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The Bravo Creek Site: A Lithic Workshop in the Klamath Mountain Foothills, Curry County, Oregon

Robert R. Munsil, Rick Minor

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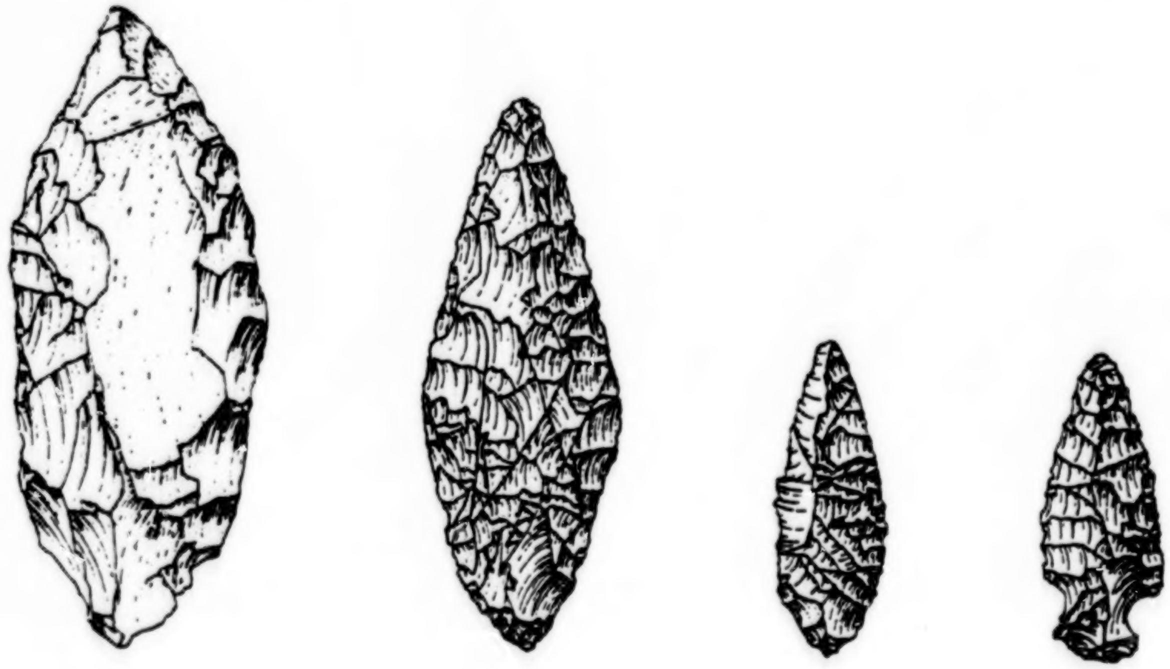

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THE BRAVO CREEK SITE: A LITHIC WORKSHOP IN THE KLAMATH MOUNTAIN FOOTHILLS, CURRY COUNTY, OREGON

by

Robert R. Musil and Rick Minor

Report to

Coos Bay District Office
Bureau of Land Management
1300 Airport Lane
North Bend, Oregon 97459-2000

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ABSTRACT

The Bravo Creek site (35CU123) is located in the foothills of the Klamath Mountains approximately 7.5 km inland from the Pacific Ocean in Curry County, Oregon. Situated on a high terrace overlooking Bravo Creek, the site contains cultural deposits with a maximum depth of 80 cm within a total site area of less than 600 m^2. Archaeological investigations in 1992 included collection of artifacts from the surface and controlled excavation of 9.8 m^3 of the cultural deposit within an area of 14 m^2. This 2.3% sample was concentrated in the portion of the site where the densest cultural deposits were located.

A total of 175 tools and 19,339 pieces of lithic debitage were recovered. With the exception of a single clay pipe stem fragment, all of the artifacts are made of stone. The most common tools represented are bifaces, unifaces, cores, and hammerstones, indicating that this site functioned primarily as a lithic workshop. The predominance of tools and debitage made of chert indicates that the reduction of this locally-available lithic material was the primary activity undertaken at this site. A radiocarbon date of 2710 ± 60 B.P. obtained from charcoal collected during the excavations may relate to natural fires rather than to human activity. Obsidian hydration age estimates suggest occupation somewhat later between circa 1650 and 350 B.P. The small narrow-necked projectile points most common at this site are assignable to the Gunther Series, which has a known time range from late prehistoric times into the historic era.

The Bravo Creek site and other archaeological sites so far investigaged in the Klamath Mountain foothills appear to represent an aspect of the settlement-subsistence system of prehistoric peoples who lived along the southern Oregon coast. On the basis of projectile point cross-dating and obsidian hydration measurments, this foothills aspect appears to have considerable antiquity, perhaps on the order of 4000-6000 years. The presence of Gunther Series projectile points indicates that the lithic workshop at the Bravo Creek site was related to the Gunther Pattern, previously defined on the basis of artifact assemblages recovered from villages and other settlements along the immediate coastal margin. The new information obtained from the Bravo Creek site and other inland localities suggests that the late prehistoric peoples of the southern Oregon coast made greater use of the Klamath Mountain foothills environment than has been previously recognized.

PREFACE AND ACKNOWLEDGEMENTS

Archaeological investigations at the Bravo Creek site were carried out under the terms of Contract No. OR952-CTO-3206, Delivery Order No. 19, between the Coos Bay District, Bureau of Land Management, and Heritage Research Associates, Inc. of Eugene, Oregon. District Archaeologist Reg Pullen acted as Contracting Officer's Representative, while Rick Minor served as Principal Investigator for Heritage Research Associates.

Archaeological fieldwork for this project was carried out from September 24-28 and October 1-6, 1992, under the direction of Robert R. Musil and Rick Minor. The field crew included Ben Breon, Jr., Alex M. Craig, James Driskell, Mary J. Haidar, Ian Hough, Russell J. Leighty, Colin Pierce, and Julie A. Ricks.

As leaf litter covered much of the ground surface during the main period of archaeological investigations, an additional visit was made to collect artifacts from the surface of the site under more favorable conditions. This task was accomplished by Rick Minor, Reg Pullen, and John Hogue on April 28, 1993. John Hogue, Cruiser-Appraiser/Forestry Technician for the Bureau of Land Management, also contributed observations on the age of the trees in the site vicinity.

Soil samples from the Bravo Creek site were analyzed at the Soils Laboratory of the Department of Geography, University of Oregon. Obsidian samples were subjected to XRF sourcing analysis by Richard E. Hughes; hydration analysis was carried out by Tom Origer of Sonoma State University.

Illustrations accompanying this report were prepared by Kevin McCornack. Final responsibility for report production was assumed by Kathryn Anne Toepel, HRA Administrator.

At the conclusion of this project, the fieldnotes and artifact collection resulting from the archaeological investigations at the Bravo Creek site were submitted for curation at the Oregon State Museum of Anthropology, University of Oregon, under Accession No. 854.

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I. INTRODUCTION

The Bravo Creek site (35CU123) is located in the foothills of the Klamath Mountains approximately 7.5 km inland from the Pacific Ocean in Curry County, Southwest Oregon. The subject of archaeological investigations in 1992, this site produced an artifact assemblage dominated by bifaces, cores, and chipped stone debitage indicating use as a lithic workshop where stone tool manufacture was the primary activity. A radiocarbon date suggests that occupation may have begun as early as 2710 years B.P. (Before Present). Obsidian hydration dates suggest a somewhat later occupation between 1650 and 350 B.P. Along with the obsidian hydration measurements, projectile point cross-dating indicates that use of the site continued into late prehistoric times. With its foothills setting and specialized function, the Bravo Creek site stands out from the great majority of prehistoric sites previously investigated along the southern Oregon coast. The procedures and results of the archaeological investigations at the Bravo Creek site are presented in this report.

LOCATION AND SETTING

The Bravo Creek Site is located approximately 500 meters upstream from the confluence of Bravo Creek with the North Fork of the Chetco River (Figure 1). The North Fork joins the main branch of the Chetco River approximately 8 km farther downstream, and the main branch flows for approximately another 8 km before reaching the Pacific Ocean at Brookings, Oregon. Overall, the Chetco River has a drainage area of 930 km^2. Like other rivers along this section of the Pacific Coast, the Chetco River is a high gradient stream with only a small estuary at its mouth (Proctor et al. 1980[4]:8.1-3).

Situated at an elevation of 107 m, the Bravo Creek site is situated within the low mountainous terrain characteristic of the foothills of the Klamath Mountains. Containing some of the oldest rocks in Oregon, the Klamath Mountains extend from the rocky headlands on the Pacific coast to high peaks in the interior reaching elevations of over 2000 m. As a whole, the Klamath Mountains are characterized by rugged, deeply incised topography with deep narrow canyons and steep ridges that have been folded, uplifted, and faulted by tectonic processes, and further shaped by hundreds of millions of years of erosion (Franklin and Dyrness 1973:13; Orr et al. 1992:51).

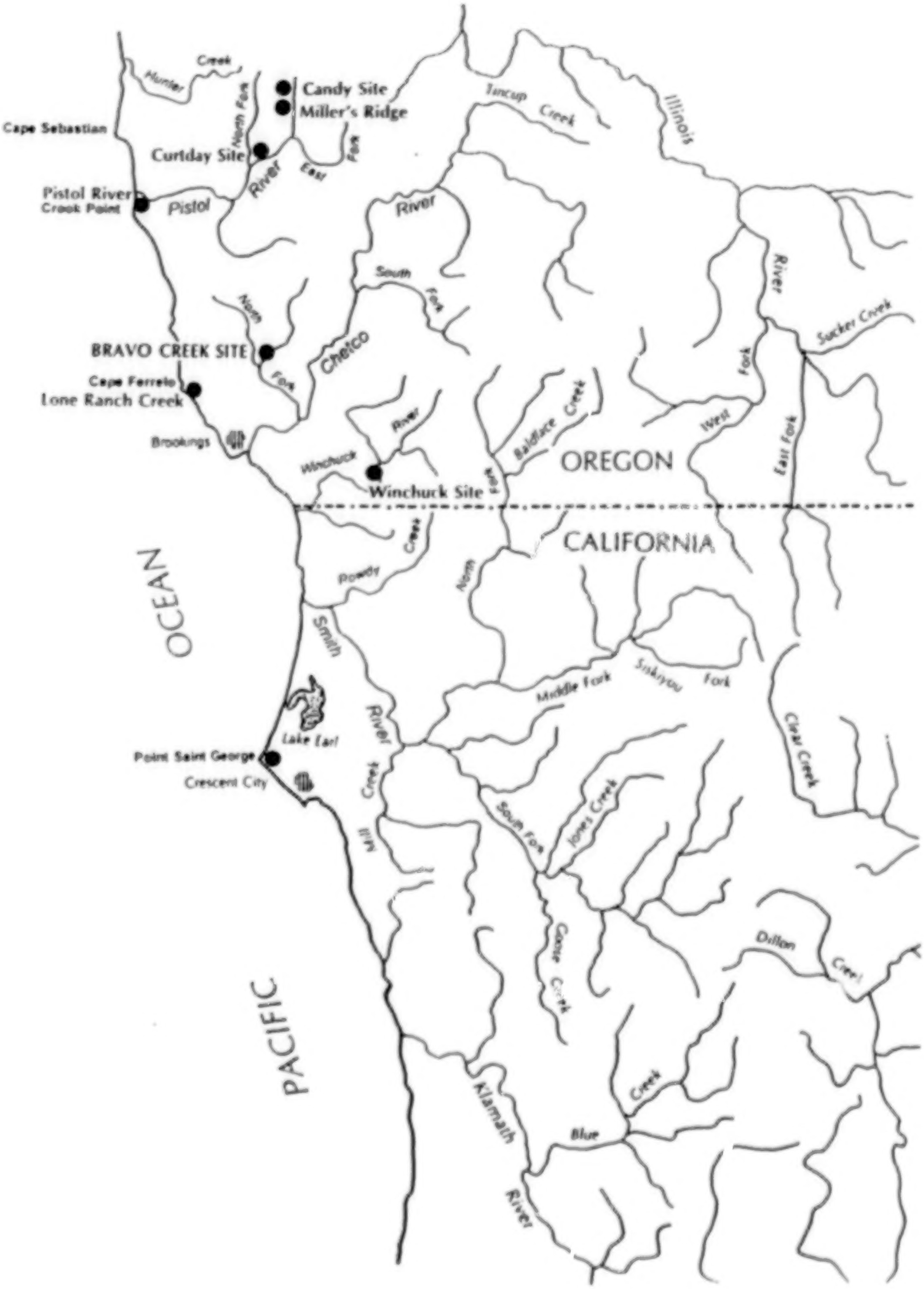


Figure 1. Location of the Bravo Creek site (35CU123) and other sites along the southern Oregon and northern California coast.

The maritime climate of the Klamath Mountains is dominated by seasonal changes in the direction of marine air flows. Moist southwesterly winds predominate during the winter and spring, resulting in the concentration of rainfall during this period. Summer and early fall are characterized by drier air flows from the north and west that result in cool dry conditions. Precipitation in the region averages from 200 to 225 cm annually with the majority of that falling as rainfall during the winter months. Mean temperatures range between 27° C in January and 36° C in July and August (Franklin and Dyrness 1973; Proctor et al. 1980[4]:8.1-5).

The Chetco River watershed is generally mapped as lying within a narrow strip of the Western Hemlock (*Tsuga heterophylla*) vegetation zone (Franklin and Dyrness 1973). However, the area surrounding the Bravo Creek site is actually transitional in nature, and includes characteristics of both the Western Hemlock and Mixed Evergreen vegetation zones. Western Hemlock is not well represented within the immediate site vicinity, and the presence of tanoak (*Lithocarpus densiflorus*), poison oak (*Rhus diversiloba*), madrone (*Arbutus menzieii*), and sclerophyllous shrubs more closely associates the site with the Mixed Evergreen Zone (Proctor et al. 1980[4]:8.1-7).

At the present time, vegetation in the site vicinity includes an overstory dominated by Douglas fir (*Psuedotsuga menziesii*) and tanoak, with myrtle (*Umbellularia californica*) and Pacific yew (*Taxus brevifolia*) also represented (Figure 2). The understory is relatively open with evergreen huckleberry (*Vaccinium ovatum*), Pacific blackberry (*Rubus ursinus*), bracken fern (*Pteridium aquilinum*), beargrass (*Xerophyllum tenax*), western trillium (*Trillium ovatum*), western starflower (*Trientalis latifolia*), redwood violet (*Viola sempervirens*), little prince's pine (*Chimaphila menziesii*), and chantrelle (*Cantharellus cibarius*) scattered among the trees.

It is important to note that the Douglas fir and tanoak trees in the vicinity of the Bravo Creek site are about the same age and are relatively young, only 50-75 years old. A few widely scattered Douglas fir in the area are 300-350 years old (Reg Pullen and John Hogue, personal communication, 1993). Thus much of the forest currently found in the site vicinity has grown up after the removal of native peoples from the Chetco River valley and within the period that modern forest management practices have been imposed in the region. Before that time, the landscape presumably was considerably more open, characterized by extensive grasslands interrupted only by scattered pine and oak trees.

The Klamath Mountains are known for their high faunal diversity. Big game species common to this rugged landscape include black-tailed deer (*Odocoileus hemionus columbianus*), Roosevelt elk (*Cervus canadensis roosevelti*), and black bear (*Eurarctos americanus*). Smaller game includes small numbers of upland bird species, martens (*Martes americana*), fishers (*Martes pennanti*), and brush rabbits (*Sylvilagus bachmani*). This region is also home to a number of threatened and endangered species including the wolverine (*Gulo luscus*), bald eagle (*Haliaeetus leucocephalus*), spotted owl (*Strix* *occidentalis*), and Peregrine falcon (*Falco peregrinus*). The rivers and streams are also host to a substantial anadromous fish population, with chinook (*Oncorhynchus tshawytscha*), coho (*Oncorhynchus kisutch*), steelhead (*Oncorhynchus mykiss*), and cutthroat trout (*Oncorhynchus clarki*) comprising the major species (Proctor et al. 1980[4]:8.1-11-1-12)

PREHISTORIC BACKGROUND

In terms of ethnographic culture areas, the southern Oregon and adjacent northern California coastal region together form the heartland of the Northwest California Province, the southernmost subdivision of the Northwest Coast culture area (Drucker 1955). This province extends along the Pacific Coast from the Coquille River in Oregon on the north to Cape Mendocino in California on the south. Although the boundaries of the Northwest California Province extend inland to the foothills of the Cascade Range, the clearest expressions of its distinctive culture and lifeways occur along the coast, and in particular along the Lower Klamath River (Kroeber 1939:30-31).

At the time of historic contact, the section of the Pacific coast between the Coquille River and Cape Mendocino was occupied by peoples who spoke Athapaskan (Tututni, Chetco, and Tolowa) and Algic (Yurok and Wiyot) languages. On linguistic grounds, these peoples are thought to have been relatively recent emigrants, arriving in the region within the last 1000 years (Elsasser 1978:50). Although the linguistic evidence thus suggests widespread replacement of earlier indigenous peoples by these emigrant groups, identification of these population changes in the archaeological record has so far proven elusive.

For the most part, previous archaeological research has documented lifeways based on subsistence practices with a marine orientation, as reflected in the presence of extensive shell midden deposits, that can be directly linked to the ethnographic peoples of the region (Elsasser 1978:50). Examples of this situation on the southern Oregon coast include the Lone Ranch Creek site which has been correlated with the Athapaskan Chetco (Berreman 1944), and the Pistol River site which is known to have been occupied by the Chetleschantunne, a division of the Tututni (Heflin 1966). The association of investigated archaeological sites with ethnographic groups is even stronger on the northern California coast, and includes Point St. George with the Tolowa (Gould 1966, 1972), Stone Lagoon (Moratto 1973; Millburn et al. 1979), Patrick's Point (Elsasser 1965; Elsasser and Heizer 1966), and Tsurai (Heizer and Mills 1952; Elsasser 1965; Elsasser and Heizer 1966) with the Yurok, and Gunther Island (Loud 1918) with the Wiyot.

Earlier cultures--antedating the ethnographic cultures--are not well documented. Evidence of an earlier cultural pattern was first reported at Point St. George, where "a flint-chipping workshop, a small hearth about 35 feet away, and quantities of finished and partly finished flint tools" were discovered (Gould 1966:87), associated with a radiocarbon date of 2260 ± 210 years B.P. (Gould 1972). This occupation contained no shell or bone tools, no stone woodworking implements or fishing equipment, and relatively little in the way of molluscan or vertebrate faunal remains, and clearly contrasted with the later component associated with the ethnographic Tolowa which was characterized by a marine shell midden and an artifact and faunal assemblage indicating a strong marine adaptation. Similar manifestations, referred to as lithic sites because the cultural remains are limited to stone tools and debitage, have subsequently been reported at a number of localities on the southern Oregon coast, including the Blundon site (Minor, Beckham, and Greenspan 1980), Blacklock Point (Ross 1984), Indian Sands and Cape Blanco (Minor and Greenspan 1991).

As of this time, then, virtually all of the archaeological research so far conducted in the southern Oregon-northern California coastal region has been carried out at sites along the immediate coastal margin. While few inland sites have been investigated, surveys indicate that considerable evidence of prehistoric activity is present in the interior, including some localities that appear to represent villages located as much as 20 to 40 km inland (Pullen 1982:102). Based on this evidence, it has been suggested that earlier peoples may have practiced a land-use pattern quite different from that of ethnographic peoples (Pullen 1982:101), one which relied more heavily on resources available in the interior (Pullen 1982:96). These issues can only be addressed through archaeological investigations at localities in inland settings away from the coastline--such as the Bravo Creek site.

PROJECT OBJECTIVES

The archaeological investigations undertaken in 1992 at the Bravo Creek site were carried out as part of the Bureau of Land Management's *Adventures in the Past* program, which provided funds for evaluation of this site in terms of its eligibility for inclusion in the National Register of Historic Places. The dense scatter of stone tools and debitage exposed on the ground surface, as well as the presence of several shallow circular depressions suggestive of housepits, led to the initial impression that the Bravo Creek site might represent a prehistoric village. The general objectives of the archaeological investigations, then, were to more firmly establish the function of this site, its age, and its significance in regional prehistory.

Unlike so many prehistoric sites that have been damaged or even destroyed by vandals, the Bravo Creek site was apparently undisturbed before the 1992 archaeological fieldwork. A secondary objective of the 1992 investigations was to record and recover the most noteworthy artifacts exposed on the ground surface before their removal by vandals. It is hoped that the removal of some of the more visible artifacts will make the presence of the Bravo Creek site less obvious, and thus tend to discourage illegal collecting and excavations at this locality in the future.

This report details the procedures and results of the 1992 archaeological investigations at the Bravo Creek site. Following this introduction, consecutive chapters provide a narrative of the fieldwork, description of the cultural materials recovered, and a discussion of the function and chronology of the site occupation. This report concludes with an assessment of the Bravo Creek site within the larger context of southern Oregon-northern California coastal prehistory.

II. EXCAVATIONS, STRATIGRAPHY, AND DATING

The Bravo Creek site occupies a small terrace measuring roughly 30 m (N-S) by 20 m (E-W) on the west side of Bravo Creek (Figure 2). The bench is bounded on the west by a ridge that separates the North Fork of the Chetco River from Bravo Creek. Trails along this ridge provide access from Bravo Creek to Bravo Prairie. Access to the site from Bravo Creek entails a climb involving a rise of 100 meters in elevation up the steep bank to the bench. The site's elevated position allows a commanding view of the Bravo Creek drainage below.

EXCAVATION STRATEGY AND PROCEDURES

The excavation strategy employed during the archaeological investigations at the Bravo Creek site was designed primarily to maximize the recovery of cultural materials from the area containing the densest cultural deposits. Test pits were also excavated to investigate the nature of the shallow circular depressions observed on the surface. In all, 15 m^2 were excavated, resulting in the removal and screening of 10.3 m^3 of fill. In addition to the excavations, an intensive collection of artifacts exposed on the ground surface was also undertaken (Figure 3).

The excavations were conducted in 1 x 1 m units. Thirteen of the 15 units excavated were grouped together into four 1 x 2 m blocks and one five m^2 block (Figure 3). Two units (5 and 12) were excavated as individual 1 x 1 m test pits. Fourteen units were placed within the confines of the small level bench; one unit (5) was placed on the steep slope on the east side of the bench (Figure 4).

The excavations were carried out using shovels and trowels. The fill from each excavation unit was removed in arbitrary 10 cm levels, subdivided where appropriate according to stratigraphy, and dry-screened through 3 mm (⅛ -inch) mesh. Vertical measurements were recorded from the ground surface. All cultural materials were collected and labeled according to the unit, level, and stratum from which they were recovered. In situ items were recorded by their exact provenience and collected separately from the material recovered in the screens. Profiles were drawn and photographs taken of walls in selected excavation units. All of the excavation units were backfilled at the conclusion of the fieldwork. An inventory of the cultural materials recovered by unit and level is provided in Appendix A.

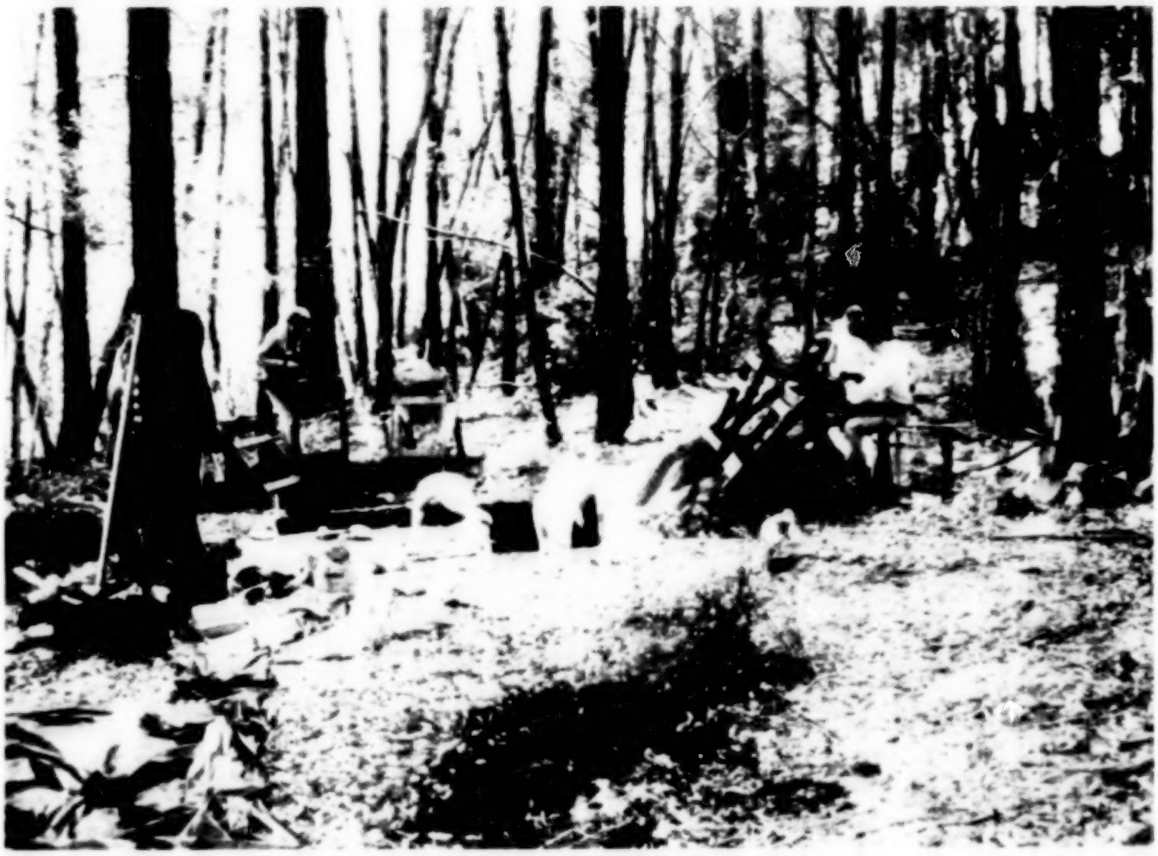


Figure 2. View to the south of the bench on which the Bravo Creek site is situated.

EXCAVATION UNIT DESCRIPTIONS

Units 1 and 2 were placed in a shallow circular depression located on the south edge of the bench. Unit 1 was placed in the center of the depression and Unit 2 on the raised edge. Unit 1 was excavated to a depth of 50 cm and Unit 2 to a depth of 80 cm. Cultural material was recovered in all levels, but decreased in the lower levels in each unit. Large quantities of charcoal and what appeared to be burnt earth were encountered throughout the fill in units 1 and 2. The evidence from these two units indicates that the shallow depression was most likely formed by a fallen tree that was either burned while standing or after it had fallen.

Test Units 3 and 4 were placed on a slightly higher area near the eastern edge of the bench. Excavations in Unit 3 reached a depth of 80 cm where large chunks of a soft siltstone or mudstone covered the south half of the unit. Unit 4 was excavated to 100 cm in depth. Cultural material was recovered in Unit 3 to a depth of 80 cm and in Unit 4 to 90 cm, although the numbers of artifacts decreased rapidly below 70 cm in both units.

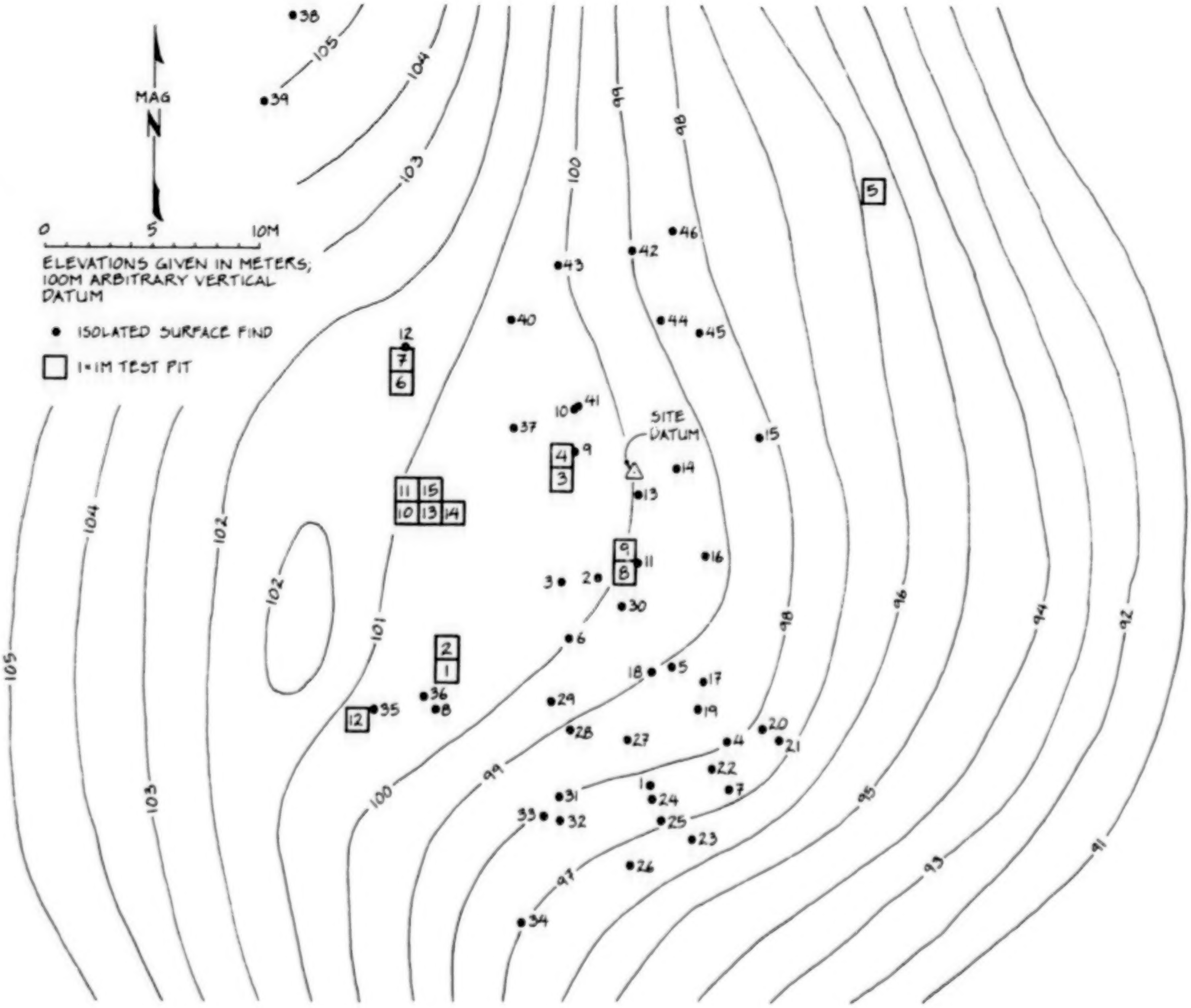


Figure 3. Topographic map of the Bravo Creek site (35CU123), showing location of excavation units and surface-collected artifacts.

Figure 4. View to the north of excavations in progress in Unit 5.

Unit 5 was placed in a circular depression on the east slope below the bench. This unit was excavated to a depth of 50 cm and did not yield any cultural material. A large amount of charcoal and burned earth was observed in the fill, especially in the northeast corner of the unit. The shape of the depression, the evidence of burning, and the lack of cultural material all suggest that this depression was created by a fallen tree.

Units 6 and 7 were placed at the north end of the bench where it begins to slope steeply to the north and west (Figure 5). Both units were excavated to 80 cm in depth with cultural material recovered throughout the deposit, although the number of cultural items decreased considerably in the bottom two levels. Chunks of decomposing silt or mudstone similar to the deposit encountered in the bottom of Units 3 and 4 were also plentiful in the lower levels of both units.

Test Units 8 and 9 were located on the east edge of the bench, just before it drops off sharply toward Bravo Creek. Both units were excavated to 60 cm in depth where the decomposing siltstone or mudstone was encountered. Artifacts were found in all of the levels excavated, but as with the other units the number of cultural items recovered decreased in the lower levels associated with the siltstone.

Test Units 10, 11, 13, 14, and 15 were placed together to form an excavation block in the center of the bench. Excavations in this block began in Units 10 and 11 (Figure 5), and the remaining three units were added later. Units 10, 11, and 13 were excavated to a depth of 80 cm, with Unit 14 stopped at 70 cm. Due to time constraints, Unit 15 was only excavated to a depth of 50 cm. Large numbers of artifacts were recovered throughout the deposit in all of these units, with a noticeable decrease occurring at 70 or 80 cm below surface. A large basalt anvilstone, surrounded by a dense concentration of angular rocks, was uncovered in levels 4 and 5 of Test Unit 13. This anvilstone was the only in situ artifact encountered that appeared to have been purposefully placed in the position in which it was found.

Test Unit 12 was placed in the southwest corner of the bench near the edge of the drop-off down to Bravo Creek. Because very little cultural material was recovered in levels 2 and 3, this unit was ended at a depth of 30 cm below the surface.

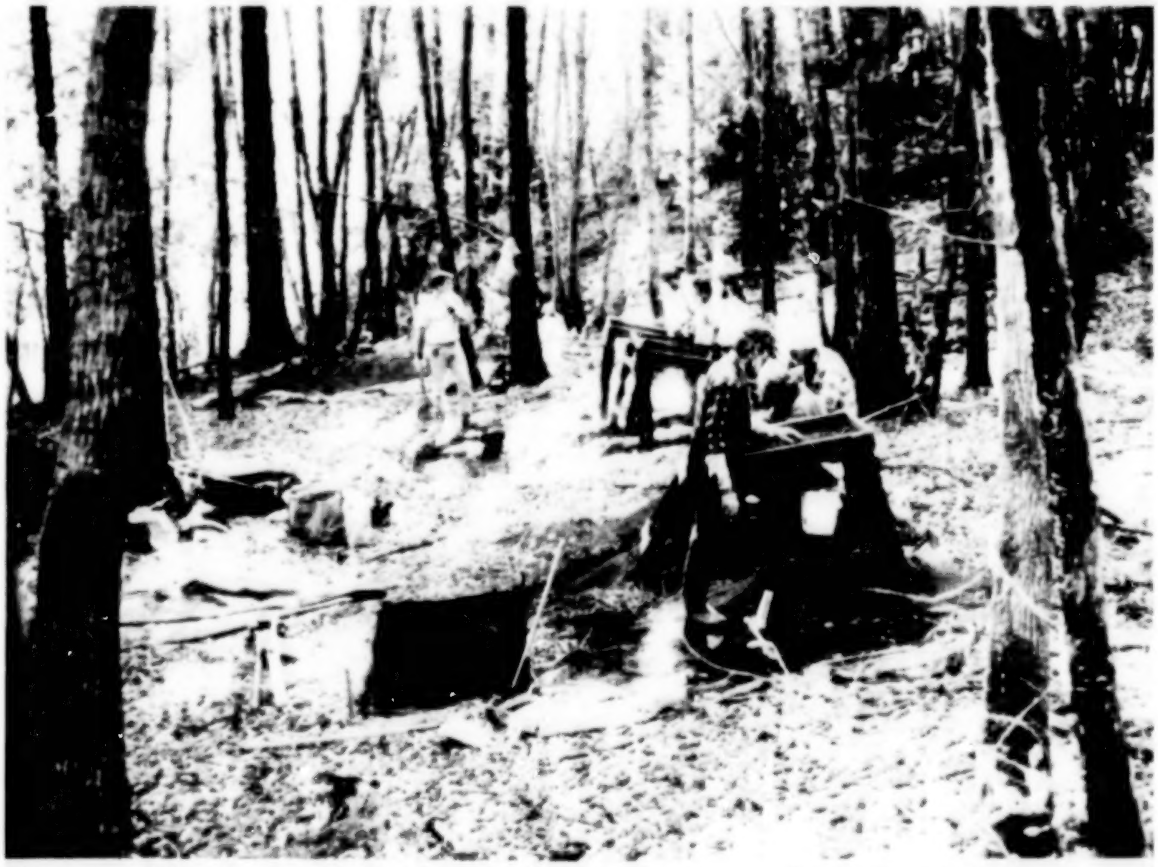


Figure 5. View to the south of excavations in progress in Units 6 and 7 (foreground) and Units 10 and 11 (background).

DESCRIPTION OF THE DEPOSITS

Sediments encountered during excavations at the Bravo Creek site consisted of two basic strata that cover this small bench to at least a depth of one meter below the ground surface (Figures 6 and 7). The upper stratum (Stratum 1) encompassed approximately the upper 60 cm of the deposit and consisted of reddish brown sandy loam. This upper stratum contained many angular gravels and large angular rocks mixed throughout the soil matrix. Numerous small roots also crisscrossed through this upper stratigraphic unit (Figure 6). The preponderance of cultural material was recovered from Stratum 1.

The lower stratum (Stratum 2) consisted of compact reddish, almost orange, sandy silt. This stratigraphic unit also included large numbers of angular gravels and rocks mixed throughout the deposit. In the excavation units near the edge of the bench (Units 8 and 9) and the one unit that reached to one meter in depth (Unit 4) chunks of decomposing siltstone or mudstone were encountered. The mudstone increased with depth and probably underlies the bench, as indicated by its presence in Units 6 and 7 as well. Very few artifacts were recovered from Stratum 2, except in the mixed transition zone between the two strata.

The bulk of the artifact assemblage, then, was recovered from the unstratified reddish brown sandy loam deposit designated Stratum 1. In order to examine the stratigraphic integrity of this deposit, 12 obsidian artifacts were submitted for hydration analysis to determine their relative ages (Appendix B). X-ray fluorescence analysis indicates that all specimens are from the Grasshopper Flat/Lost Iron Well/Red Switchback source in the Medicine Lake Highlands of northeastern California (Appendix C). The hydration measurements obtained can be used to arrive at an assessment of the "net stratigraphic value" of this cultural deposit, defined as "the degree to which the superimposed subdivisions of the midden deposit selected accurately reflect the order of cultural succession" (Michels 1969:15).

There is an overall trend towards superposition in the deposits, with all of the specimens that yielded hydration measurements less than 1.4 microns being recovered in the upper 30 cm. At the same time, however, the highest values of 2.5 and 2.6 microns were obtained from three specimens recovered from only 10-20 cm below surface, indicating that some older specimens have been mixed into the upper levels of the cultural deposit (Figure 8). The hydration measurements exhibit two clusters, one with a mean of approximately 1.2 microns and the other with a mean of approximately 2.3 microns. This situation suggests that two distinct occupations, or cultural components, may be represented.

However, the relationship between hydration band width and depth below surface is relatively weak, with a correlation coefficient (*r*) of 0.41 and a coefficient of determination (r^2) measuring only 0.17. The coefficient of determination suggests that

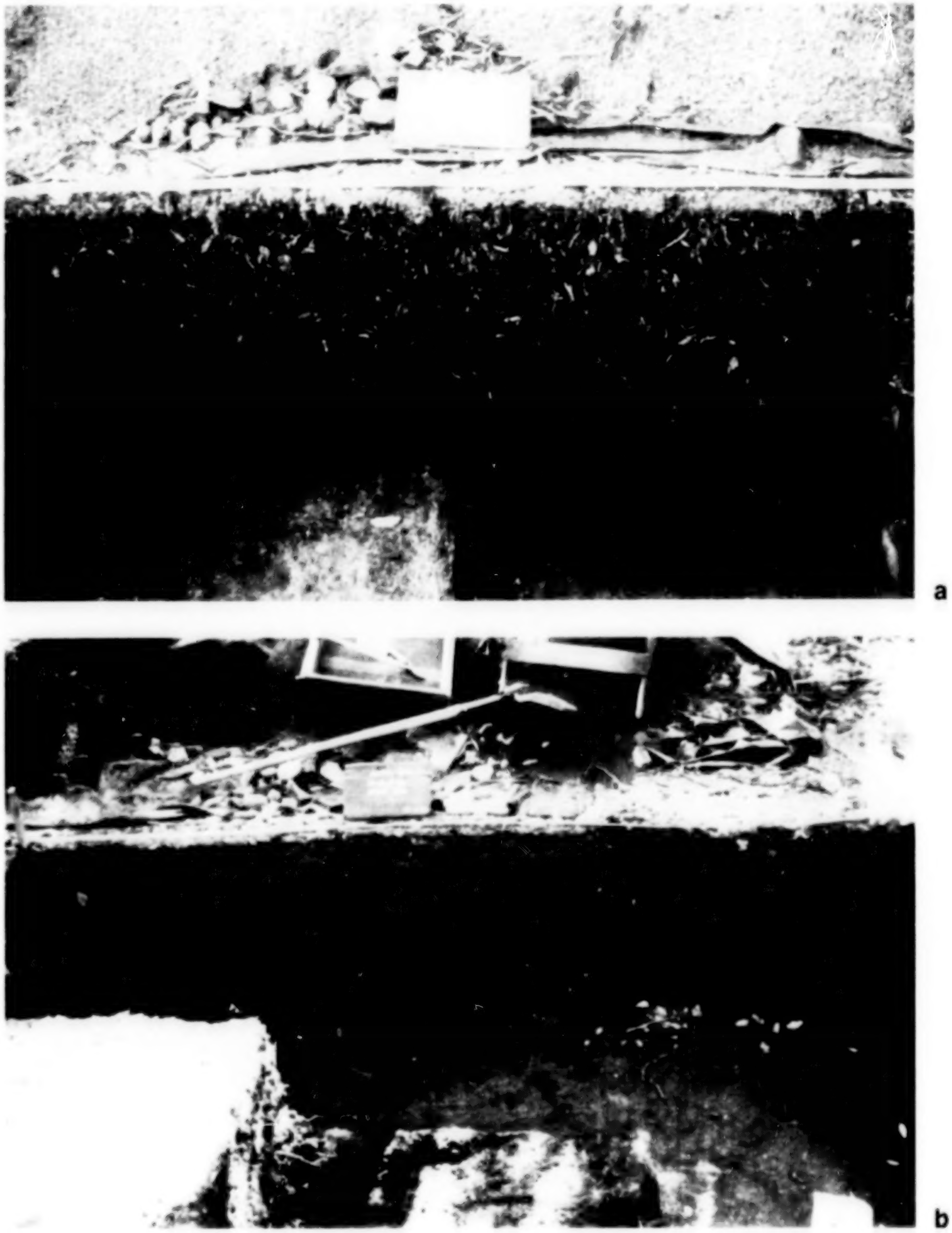
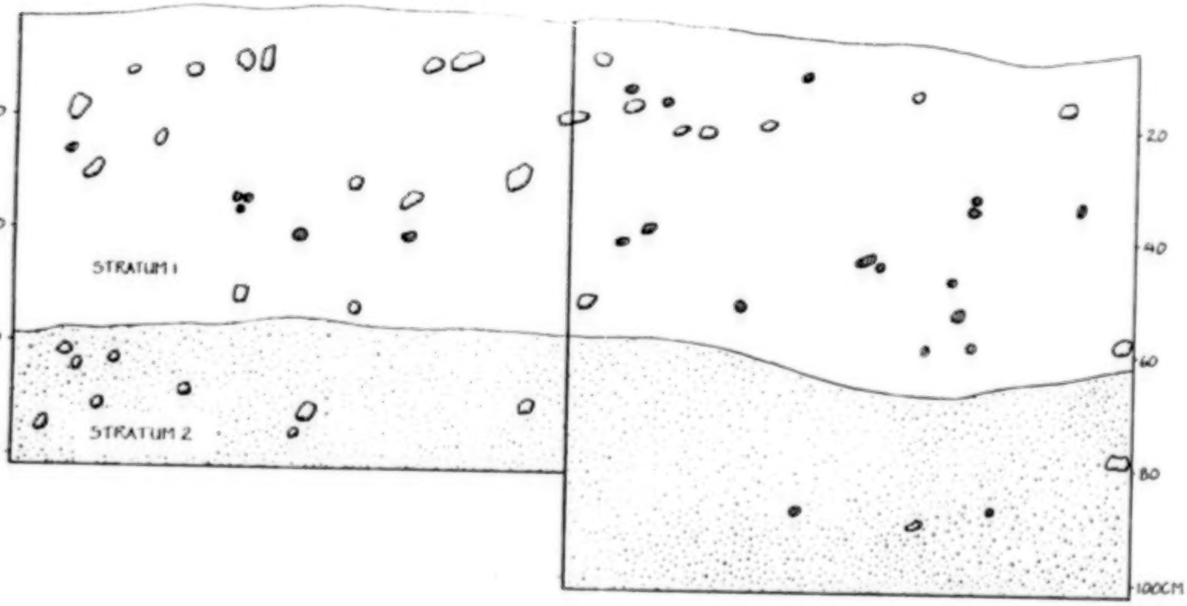
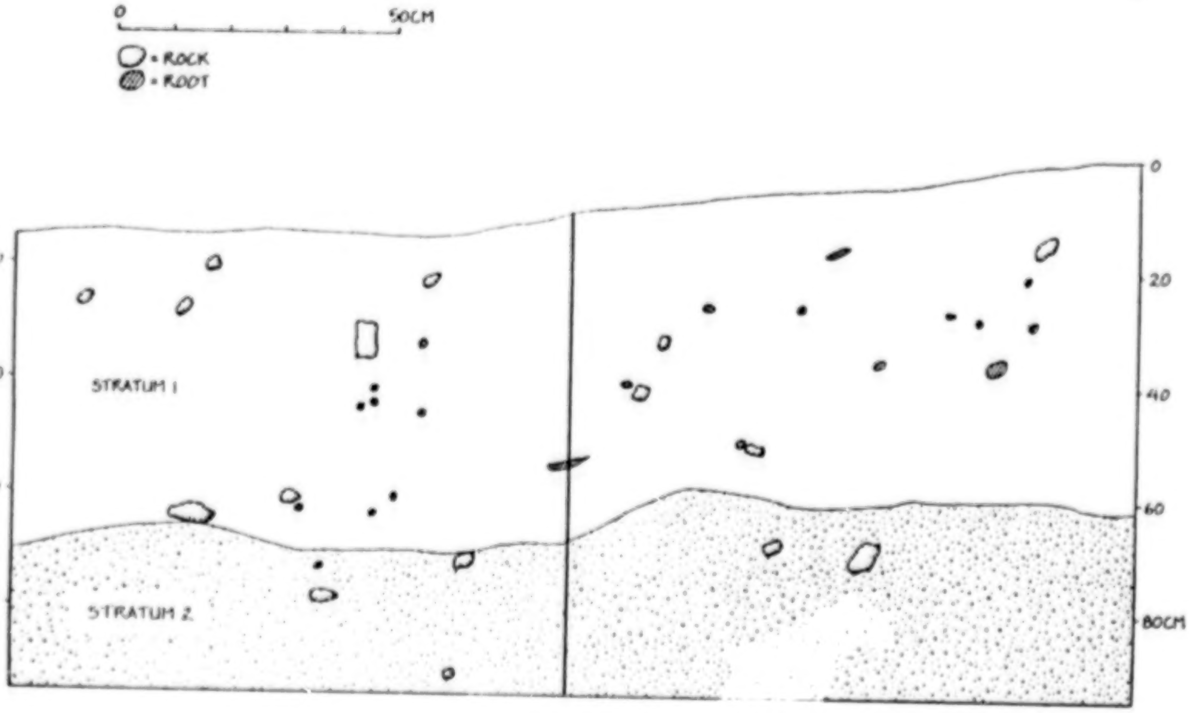


Figure 6. View of the west wall profile of Test Units 3 and 4 (a) and the south wall profile of Test Units 10, 13, and 14 (right to left).


STRATUM 1
STRATUM 2
100CM

a


50CM
= ROCK
= ROOT
STRATUM 1
STRATUM 2
80CM

b

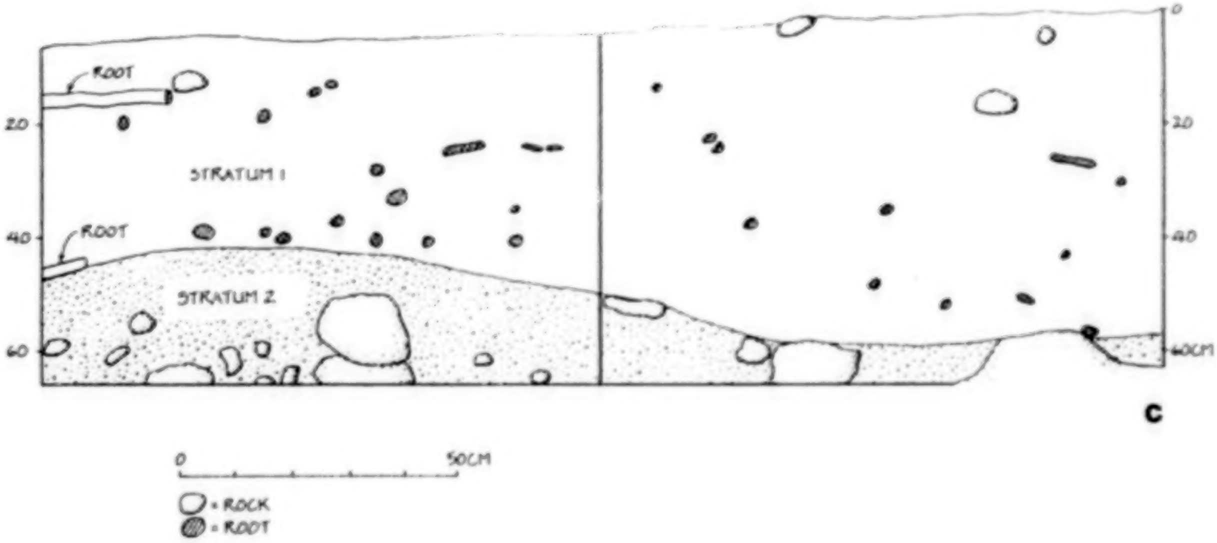


Figure 7. West wall profiles of Test Units 3 and 4 (a), 6 and 7 (b), and 8 and 9 (c).

the thickness of the band on a hydrated specimen is only weakly correlated with the depth at which the artifact was recovered. Michels (1969) suggests that the scattering of artifacts with different hydration readings throughout a cultural deposit is an indication of considerable mixing within those deposits, and that such a site has very little stratigraphic value. However, given the known inconsistencies associated with the hydration process (caused by variations in temperature and humidity, chemical composition of the obsidian, and the effects of burning), the wide range of hydration measurements may be more a result of the hydration process itself instead of a lack of stratigraphic integrity (Friedman and Smith 1960; Friedman and Trembour 1983; Michels 1973; Michels and Tsong 1980).

CHRONOLOGY

A considerable amount of charcoal was observed in the cultural deposit during the excavations. The charcoal occurred as small flecks or chunks more or less throughout the entire cultural deposit. Due to the history of recurrent natural fires throughout the prehistoric past, the extent to which most of this charcoal was associated with prehistoric occupation is unclear. Nevertheless, charcoal was collected while screening the cultural deposit removed from the excavation units on the bench.

In an effort to provide some idea as to the age of the site occupation, one sample of charcoal was submitted for radiocarbon analysis. Unlike the other charcoal collected, this sample, recovered from Level 5 (40-50 cm below surface) in Test Pit 10, was a

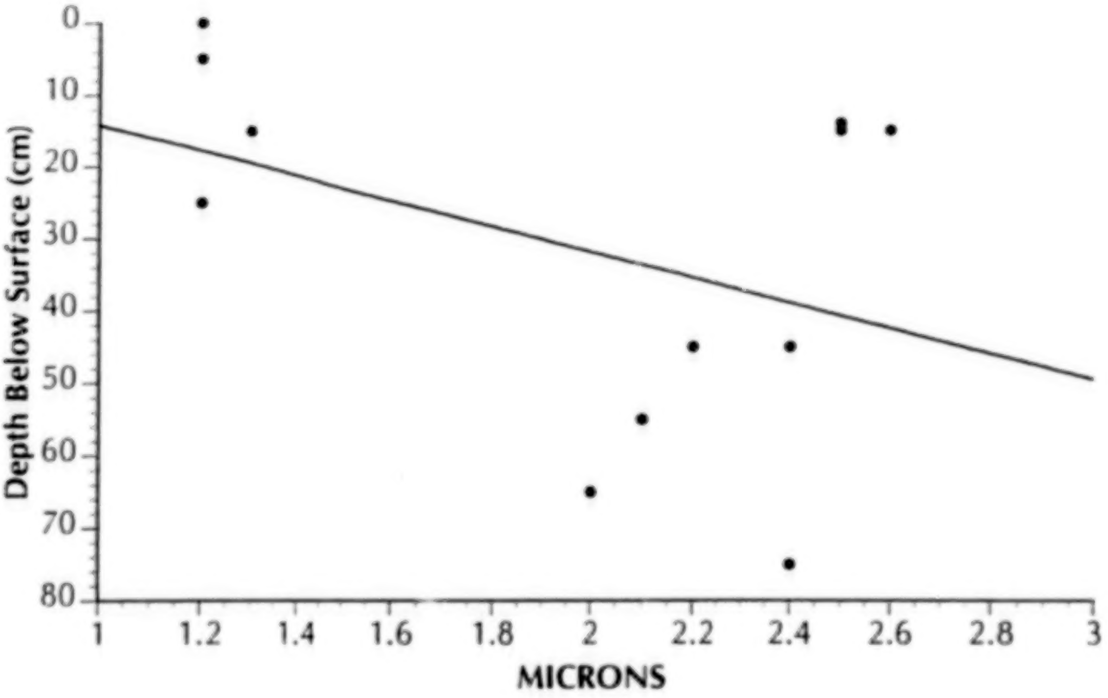


Figure 8. Obsidian hydration measurements by depth below surface (trend line is linear).

larger concentration that appeared to be associated with an increased density of cultural material. This concentration of cultural material, which included an anvilstone and hundreds of pieces of lithic debitage, was primarily situated in Unit 13 adjacent to Unit 10.

This charcoal sample produced a radiocarbon date of 2710 ± 60 B.P. (Beta-61923). This date is reasonably consistent with the known time range of the projectile point types recovered at the Bravo Creek site. As the charcoal sample was recovered from 40-50 cm below surface, and cultural materials were recovered as deep as 70-80 cm below surface, this radiocarbon date raises the possibility that occupation of the site may have begun somewhat earlier and continued much later in time.

Another means of estimating the chronology of the Bravo Creek site occupation is through correlation of the obsidian hydration values with an obsidian hydration rate. Application of an obsidian hydration rate to this data set requires (1) that the chemical content of the obsidian specimens be held constant, and (2) that a hydration rate that reflects local climatic conditions be available. The first condition is met by the results of x-ray fluorescence (XRF) analysis carried out on the same 12 specimens previously subjected to hydration analysis. As previously noted, all 12 specimens were traced to the Grasshopper Flat/Lost Iron Well/Red Switchback (GF/LIW/RS) source in northeast California (Appendix C).

A rate for hydration of obsidian in the southern Oregon coastal region has not yet been calculated. In the absence of a local hydration rate, the rate calculated by Connolly for the Elk Creek locality in the upper Rogue River Basin is employed (Connolly 1991:46-47). Previous obsidian studies in the Elk Creek locality indicate that this rate should be applicable to obsidian from the Grasshopper Flat/Lost Iron Well/Red Switchback (GF/LIW/RS) source (Pettigrew and Lebow 1987:9.10-9.11). Connolly calculated an obsidian hydration rate of 4.1 microns^2 per 1000 radiocarbon years for the Elk Creek locality. Applying this rate to hydration values from the Bravo Creek site yields obsidian hydration dates ranging from 1649 to 351 years.

Application of the obsidian hydration rate from the upper Rogue River Basin to obsidian specimens from the Bravo Creek site some 140 km to the southwest must be done with caution. While the mean annual temperatures in Brookings (53.4°) and Medford (53.4°) are similar (Sternes 1974), seasonal temperature fluctuations on either side of the Coast Range naturally vary somewhat, and these variations may have affected the hydration rate of obsidian artifacts. Assuming that the obsidian hydration dates are reasonably accurate, however, their limited time range of 1649 to 351 years raises some question as to whether the much earlier radiocarbon date of 2710 ± 60 B.P. is in fact associated with prehistoric occupation at the Bravo Creek site.

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III. DESCRIPTION OF ARTIFACTS

A total of 175 tools and 19,339 pieces of lithic debitage were recovered during the field investigations at the Bravo Creek site. Of that total, all of the artifacts, except for a single clay pipe stem fragment, are made of stone. The stone tools have been divided into the general categories of flaked stone and cobble tools. The flaked stone tools consist of obsidian, chert, and basalt specimens that were produced either by unifacial or bifacial flaking techniques. The cobble tool category includes the large heavier implements that were either manufactured from or consist of rounded cobbles of basalt, sandstone, or schist.

The artifacts were catalogued using a system that designates the 1 x 1 m excavation unit, 10 cm level, and stratum from which each item was recovered. Each artifact number begins with the unit number and is followed by the level and stratum designations, and ends with a serial number that consecutively records each artifact within a specific provenience. Thus projectile point TP2-5/1-1 was the first artifact recovered from Stratum 1 of Level 5 in Test Pit 2. The artifacts recovered from the surface were recorded consecutively as Isolated Finds (IF) 1-46. An inventory of the artifacts recovered, including data on the distribution of the various artifact classes within the site's cultural deposit, is presented in Appendix A.

FLAKED STONE TOOLS

A total of 138 flaked stone tools were recovered. Most of the flaked stone tools (133) are made of chert (96%), with obsidian (3%) totaling four tools, and basalt (1%) represented by just a single used flake. The majority (66%) of the flaked stone tools exhibit bifacial flaking; the remainder (34%) exhibit either unifacial modification or are cores.

The flaked stone tools made from chert appear to all be products created during the reduction of locally-available chert nodules and cobbles that occur in abundance in seams in the ridge above the site as well as in the gravels of Bravo Creek. Basalt is also available locally, but was not used for tool stone to the degree seen with the local chert. The predominance of chert artifacts (including debitage) in the assemblage indicates that the reduction of this plentiful lithic resource was the major activity undertaken at this site.

In contrast to the chert material, the few obsidian tools recovered were all imported to the site from some distance as either finished tools or blanks (see below). The recovery of four obsidian tool fragments indicates that these obsidian items were also being further reduced or repaired at the site in conjunction with the reduction of the more prevalent chert material.

The flaked stone tools recovered appear, for the most part, to be representative of lithic reduction activities. In particular, the chert tool assemblage includes examples of all stages of core and biface reduction. The flaked stone tools are described below based on their position within the lithic reduction sequence (Callahan 1979).

Cores

The artifacts recovered from the Bravo Creek site were made predominately of chert. The assemblage contains many large cortex-covered flakes and chunks that had been removed from large water-worn cobbles apparently collected from the creek bed. Based on the presence of large numbers of blocky chunks and split cobbles, as well as the recovery of numerous anvilstones and hammerstones, it appears that bipolar and anvil techniques of reduction (Crabtree 1972) were used to reduce the chert nodules. The rounded nodules were split or broken apart in an attempt to produce a flat surface suitable for use as a striking platform. Many of the nodules were not of good quality and contained imperfections and irregularities that resulted in the nodules shattering into irregular multifaceted chunks unsuitable for use as cores. Much of the debitage collected consists of large blocky irregular chunks produced during the splitting of these nodules. The poor quality of the lithic material resulted in the accumulation of a considerable amount of large cortex-covered core reduction flakes and angular debris in relation to the number of tools recovered.

If a split cobble or angular chunk was produced that provided a flat surface suitable for use as a striking platform, then flakes were generally removed along this edge, creating a core. Many of the large blocky chunks recovered exhibited one negative flake scar, indicating that these pieces had had a flake removed from them, but only 15 specimens displayed more than one negative flake scar indicating that they were used as cores (Table 1). Five of the cores exhibit unidirectional flake scars along one edge of a rough irregular split cobble (Figure 9,a-b). The cortex-covered exterior of the original nodule on four of the five unidirectional cores served as the striking platform, while the striking platform on the one remaining unidirectional core consisted of a flat surface produced during the splitting of the cobble. None of the striking platforms on the unidirectional cores displayed any evidence of preparation.

Eight of the cores are large multi-faceted angular blocks that display multidirectional flake scars. The flake scars on these cores are non-patterned and the striking platforms changed location with every flake removed (Figure 9,c-d). Five of the eight

Table 1. Metric attributes for cores.

Specimen Number	Measurements (mm and grams)				Core Type	Raw Material
	Length	Width	Thickness	Weight		
IF-14	60.9	44.9	37.4	92.82	Multidirectional	Chert
TP1-3/1-2	38.9	42.4	42.6	51.78	Unidirectional	Chert
TP2-1/1-4	76.0	70.2	49.9	207.4	Multidirectional	Chert
TP2-3/1-6	56.8	45.1	41.3	112.74	Multidirectional	Chert
TP2-4/1-2	29.6	16.0	12.0	6.51	Cylindrical	Chert
TP3-1/1-3	31.3	17.2	16.3	7.99	Cylindrical	Chert
TP3-4/1-2	69.5	40.8	26.7	53.07	Unidirectional	Chert
TP3/5/1-3	62.8	54.1	60.9	190.39	Multidirectional	Chert
TP4-2/1-5	64.3	58.8	40.8	138.22	Multidirectional	Chert
TP4-2/1-6	71.8	46.3	67.4	235.60	Unidirectional	Chert
TP4-2/1-7	95.5	87.8	61.2	419.37	Multidirectional	Chert
TP10-2/1-6	103.5	81.0	53.0	428.99	Unidirectional	Chert
TP11-2/1-2	68.5	65.9	26.6	97.3	Unidirectional	Chert
TP13-5/1-2	66.6	46.3	28.1	71.71	Multidirectional	Chert
TP15-2/1-1	57.2	44.3	33.3	60.2	Multidirectional	Chert

cores are portions of split nodules that still retain much of the cortex-covered exterior, while the remaining three cores are large angular interior chunks that lack cortex. As with the unidirectional cores, none of the multidirectional cores exhibited any preparation of the striking platforms.

The remaining two cores are small tabular chert specimens that are cylindrical in cross-section and exhibit long narrow flake scars around their circumference (Figure 9,e-f). These small pieces appear to be exhausted bipolar cores that were produced from tabular chunks removed from the interior of natural cobbles. These cylindrical cores, which would have produced small narrow blade-like flakes, are the only prepared cores recovered from the site.

Bifaces

Core reduction resulted in the production of flake blanks (Stage 1) that were further reduced by bifacial reduction techniques into stage reduction bifaces (Table 2). A number of the early stage bifaces recovered were made on large thick flakes, some with cortex still remaining on the dorsal surface, while others were made on small thin interior flakes. It appears from the bifaces recovered that in order to produce flakes large enough to reduce into a desired end product flakes produced from the low-grade chert material available would have had to have been quite thick. As well, because of

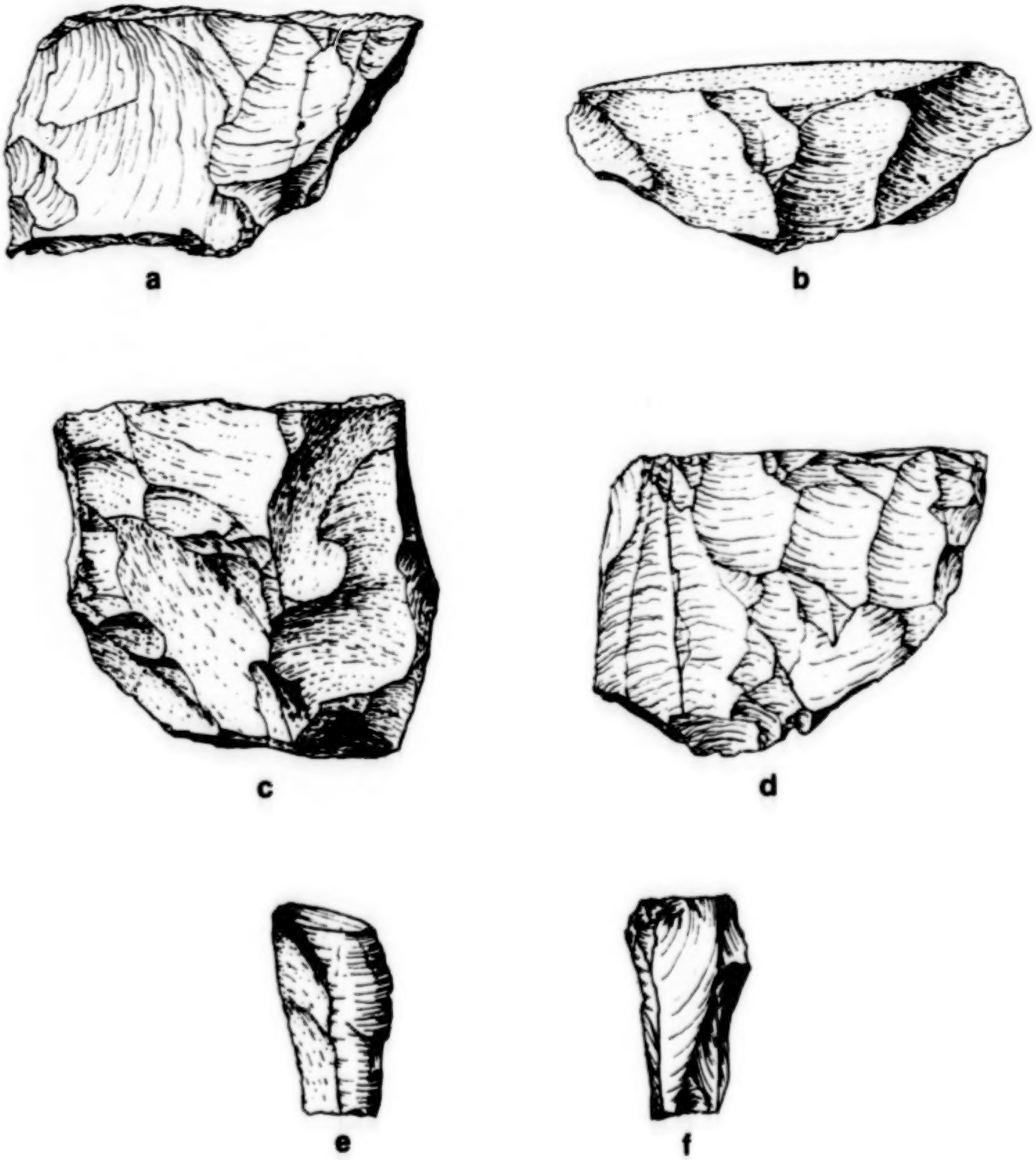

Figure 9. Cores: a-b, unidirectional; c-d, multidirectional; e-f, bipolar/cylindrical (shown actual size).

a. TP3-4/1-2 b. TP11-2/1-2 c. TP3-5/1-3 d. TP13-5/1-2 e. TP2-4/1-2 f. TP3-1/1-3

Table 2. Metric attributes for bifaces.

Specimen Number	Measurements (mm and grams)					Raw Material	Reduction Stage	Comments
	L	MW	Th	BW	Wt			
IF-1	69.5	26.7	10.8	-	17.42	Chert	4	Complete
IF-2	37.2	20.6	8.6	-	6.65	Chert	4	Tip Fragment
IF-3	28.4	18.0	5.7	-	3.57	Chert	4	Midsection
IF-4	81.5	34.0	14.0	-	29.52	Chert	3	Complete
IF-5	39.2	40.8	9.8	-	16.3	Chert	4	Midsection
IF-7	94.1	55.0	21.3	-	99.36	Chert	2	Complete
IF-9	33.0	39.5	8.7	-	16.53	Chert	3	End Fragment
IF-11	43.2	22.9	10.1	-	13.14	Chert	3	End Fragment
IF-13	61.9	28.9	13.5	-	19.27	Chert	2	Complete
IF-21	28.3	28.4	12.4	-	10.05	Chert	4	Midsection
IF-29	73.8	38.4	14.3	-	37.06	Chert	2	Complete
IF-30	38.3	27.6	7.8	-	10.24	Chert	3	End Fragment
IF-32	37.7	28.7	10.4	-	13.0	Chert	3	End Fragment
IF-33	35.6	21.9	4.9	-	3.33	Chert	2	Complete
TP1-1/1-1	37.9	22.2	7.1	-	6.29	Chert	4	End Fragment
TP1-1/1-2	46.2	28.8	14.6	-	20.59	Chert	3	End Fragment
TP1-3/1-1	32.3	16.2	4.8	-	2.15	Chert	2	Complete
TP1-4/1-1	17.6	6.8	5.7	-	0.61	Chert	4	Edge Fragment
TP2-1/1-1	32.4	37.2	12.6	-	13.98	Chert	4	End Fragment
TP2-1/1-2	41.4	34.1	13.3	-	16.65	Chert	3	End Fragment
TP2-1/1-3	37.7	20.3	9.3	-	5.43	Chert	2	Edge Fragment
TP2-3/1-1	38.7	35.4	11.1	-	12.54	Chert	3	End Fragment
TP2-3/1-2	13.0	30.5	9.1	-	4.27	Chert	4	Midsection
TP2-3/1-3	54.0	38.8	8.0	-	16.50	Obsidian	5	Midsection
TP2-4/1-1	54.3	37.7	17.5	-	41.74	Chert	2	Edge Fragment
TP2-5/2-3	60.9	31.1	14.8	22.1	29.05	Chert	3	Complete
TP2-6/2-1	65.5	54.1	18.1	-	72.00	Chert	2	Complete
TP2-6/2-2	13.0	29.3	5.9	-	2.01	Chert	4	End Fragment
TP3-3/1-1	23.3	14.0	4.3	-	1.12	Chert	2	End Fragment
TP3-3/1-2	45.4	32.8	16.5	-	22.78	Chert	2	End Fragment
TP3-4/1-1	19.4	27.6	8.4	-	3.76	Chert	4	End Fragment
TP3-5/1-2	15.3	11.8	5.5	-	0.79	Chert	4	Tip Fragment
TP3-6/2-2	48.6	29.5	14.0	-	15.38	Chert	2	Edge Fragment
TP3-7/2-1	16.9	6.6	5.8	-	0.54	Obsidian	2	Edge Fragment
TP4-2/1-2	18.9	7.0	2.5	-	0.32	Chert	5	Tip Fragment
TP4-4/1-2	28.6	13.9	7.3	-	2.64	Chert	4	End Broken
TP4-4/1-3	9.0	18.7	8.9	-	0.63	Obsidian	5	Edge Fragment
TP4-4/1-5	67.8	41.1	19.7	-	50.00	Chert	2	End Fragment
TP4-6/1-1	21.4	12.9	5.2	-	1.11	Chert	2	End Fragment
TP6-1/1-2	31.9	28.6	10.3	-	8.80	Chert	2	Midsection
TP6-4/1-1	29.7	15.9	4.4	-	1.78	Chert	4	Complete
TP6-5/1-1	50.8	38.5	7.9	-	12.80	Chert	3	End Fragment
TP6-6/1/1	33.4	14.9	5.8	-	2.16	Chert	2	Complete
TP7-4/1-1	26.1	18.2	6.2	-	2.16	Chert	4	Tip Fragment
TP8-2/1-1	32.2	30.3	13.5	-	12.42	Chert	3	End Fragment
TP8-3/1-1	44.2	25.6	8.8	-	8.12	Chert	4	Complete

Table 2 (continued)

Specimen Number	Measurements (mm and grams)					Raw Material	Reduction Stage	Comments
	L	MW	Th	BW	Wt			
TP9-1/1-1	20.9	21.6	18.1	-	3.47	Chert	3	End Fragment
TP9-3/1-1	29.9	27.6	10.5	-	6.23	Chert	3	End Fragment
TP9-4/1-1	23.5	26.7	6.1	-	3.69	Chert	2	End Fragment
TP9-4/1-3	62.2	64.2	24.2	-	88.68	Chert	2	End Fragment
TP9-6/2-1	25.8	14.0	6.7	-	2.18	Chert	5	End Fragment
TP10-2/1-2	19.2	11.2	5.2	-	1.28	Chert	4	Edge Fragment
TP10-2/1-4	79.1	50.9	19.7	-	82.89	Chert	2	Complete
TP10-3/1-1	34.2	18.9	8.3	-	4.85	Chert	4	Edge Broken
TP10-6/1-1	25.9	21.2	4.8	-	2.95	Chert	2	End Fragment
TP10-6/1-2	12.8	15.3	2.1	-	0.44	Chert	2	End Fragment
TP11-1/1-1	47.1	27.9	15.2	-	14.93	Chert	3	Complete
TP11-1/1-2	27.9	6.3	9.3	-	1.41	Chert	3	Edge Fragment
TP11-5/1-1	62.0	37.7	13.7	-	24.66	Chert	2	Complete
TP11-5/1-2	18.7	12.5	9.6	-	1.93	Chert	4	Edge Fragment
TP11-5/1-4	35.0	24.2	10.2	-	5.55	Chert	2	Edge Fragment
TP12-1/1-1	20.0	16.5	6.4	-	1.23	Chert	4	Tip Fragment
TP13-2/1-1	47.8	22.6	9.4	-	8.26	Chert	3	Complete
TP13-2/1-2	46.3	40.9	14.5	-	29.30	Chert	4	End Fragment
TP13-5/1-1	33.3	27.3	8.6	-	7.00	Chert	2	End Fragment
TP13-6/1/1	22.0	18.2	7.1	-	2.53	Chert	4	Tip Fragment
TP14-1/1-1	15.9	12.8	2.9	-	0.37	Chert	5	Tip Fragment
TP14-1/1-2	69.3	43.7	20.3	-	55.00	Chert	3	Complete
TP14-1/1-3	51.0	42.4	20.3	-	37.65	Chert	2	Complete
TP14-1/1-4	28.3	17.9	3.7	-	2.03	Chert	2	End Fragment
TP14-1/1-5	24.9	25.9	5.9	-	3.61	Chert	2	Complete
TP14-1/1-6	40.0	17.4	9.2	-	6.27	Chert	2	Edge Fragment
TP14-6/1-1	44.8	24.3	7.0	-	7.17	Chert	2	Complete
TP14-7/2-1	15.9	12.1	3.0	-	0.51	Chert	5	End Fragment
TP15-4/1-1	64.8	27.3	10.2	-	12.58	Chert	3	Edge Fragment

the low quality of the raw material these large flake blanks were also very irregular in outline and cross-section. The large flake blanks obtained required considerable primary thinning due to their thick cross-sections and to remove the humps and other irregularities present on the dorsal surface. It appears that it was extremely difficult to produce a large thin flake from the natural chert nodules available at this site. The production of large thick flake blanks required considerable primary thinning in an effort to thin the blank before shaping, thus producing large amounts of debitage reflecting the early reduction stages.

In contrast to the large flake blanks, a number of smaller and much thinner early stage bifaces made on small thin flake blanks were also recovered. Due to their already thin cross-sections, these blanks required very little primary thinning and the early stages of reduction on these blanks was restricted for the most part to edging and shaping.

Early Stage Bifaces

The Stage 2 bifaces include fourteen specimens that have very thick irregular cross-sections and rough sinuous edges. These pieces all exhibit deep wide flake scars, many of which reach or cross the midline and often terminate in step or hinge fractures. All of these early stage bifaces still retain large unmodified portions of the original flake blank on both faces, with five of the bifaces still retaining cortex on the dorsal surface. All of the bifaces are rough unshaped pieces that have been flaked by hard hammer percussion, and most have excessively thick edges (Figure 10,a-d). Many of the larger early stage bifaces are complete specimens suggesting that they were discarded due to the difficulty of overcoming the thick humps or step-fractures on the surface and along the edges of the pieces, thus making further thinning unproductive.

In contrast to the large thick bifaces, 15 of the early stage bifaces are small thin flakes to which bifacial flaking was applied only along the edges of the flake blank. This initial edging was also used to begin shaping the piece, and most of the thin flake blanks have either pointed or rounded ends (Figure 10,e-l). The central portions on both faces of these small bifaces remain unmodified and the orientation of the original flake blank is apparent in all specimens. The outlines of these bifaces are irregular and the lateral edges are sinuous, with the curvature of the original flake blank still evident in long section.

A single large obsidian biface was recovered from Test Pit 2. Like the chert specimens, this biface exhibits small short parallel bifacial pressure flaking along both lateral margins, with large portions of the interior of the original flake blank remaining unmodified (Figure 10m). This is the only early stage obsidian biface recovered from the site, and it provides the only evidence that obsidian flake blanks were also being reduced at this locality.

Mid-Stage Bifaces

A total of 18 Stage 3 bifaces were recovered. All of these specimens exhibit deep wide flake scars oriented from the lateral margins toward the midline of the biface. The flake removals are not regularized, but many reach or cross the midline of the piece. These pieces are irregular in outline with uneven sinuous edges, but in addition to being thinned across both faces they have been shaped into rounded or bi-pointed bifacial blanks. Many of the pieces still have an irregular cross-section with humps and step fractures present in places on both faces. Although these pieces have been shaped and flaked across both faces they still have a very rough irregular appearance.

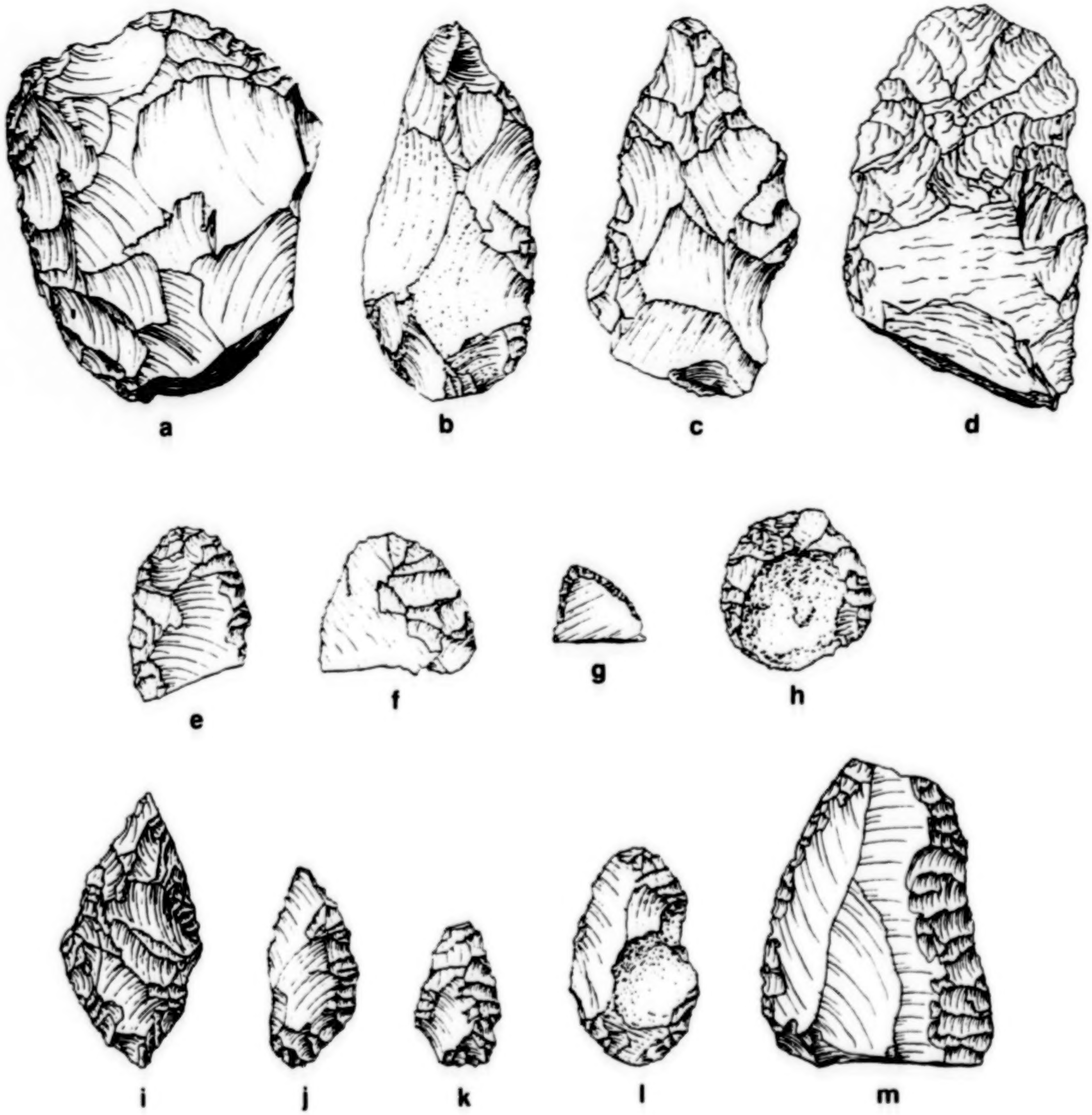

Figure 10. Early stage bifaces: Stage 2 (shown actual size).

a. TP2-6/2-1 b. IF-13 c. TP11-5/1 d. TP4-4/1-5 e. TP10-6/1-1
f. TP9-4/1-1 g. TP10-6/1-2 h. TP14-1/1-5 i. TP14-6/1-1 j. TP1-3/1-1
k. TP3-3/1-1 l. IF-33 m. TP2-3/1-1

Eleven of the Stage 3 bifaces are end fragments that have been broken by bend or perverse fractures, many across the midline of the biface (Figure 11,a-f). A single edge fragment was also recovered. Six of the bifaces are complete specimens that are thick in cross-section and have many irregular humps and step fractures on at least one surface (Figure 11,g-k). It appears that the complete specimens were discarded at this stage of reduction because these imperfections could not be overcome.

Twenty-two of the bifaces recovered represent the next stage in the reduction process (Stage 4). These pieces are more finely flaked, with more regularized and patterned flake scars covering both faces. The Stage 4 bifaces display a flattened lenticular cross-section and straighter more regularized edges. The surfaces of the Stage 4 bifaces are smoother with very few, if any, humps or step fractures. These pieces have been shaped into a generalized outline that presents a more refined appearance than the Stage 3 bifaces. Many of the specimens at this stage can be oriented as to their distal and proximal ends. The flake scars on Stage 4 bifaces tend to be shallower and more controlled, with flake removals oriented as a series along the edges toward the center of the piece. None of the Stage 4 bifaces display any cortex, indicating that the debitage created at this stage would for the most part consist of medium- to small-size interior flakes.

Ten of the Stage 4 bifaces are tip or end fragments that were broken by bend or perverse fractures during manufacture (Figure 12,a-f). Three pieces are midsection fragments that also broke from the parent piece as a result of bend or perverse fractures (Figure 12,g-i). Three small edge fragments were also recovered. The remaining five specimens are either complete bifaces or complete pieces that have only the tip or an edge broken off. Three of the complete bifaces show the size range represented at this site (Figure 12,j-l). The two larger bi-pointed bifaces were made on large thick flakes (Figure 12,j-k). The small thin leaf-shaped biface was shaped on a small thin green chert flake using initial edging and then selected secondary thinning where needed. This small biface still retains unmodified portions of the original flake blank in the center of the piece on both faces at this stage (Figure 12l).

Late Stage Bifaces

Four small chert and three obsidian biface fragments exhibit very regular parallel or collateral flaking on both faces characteristic of Stage 4 bifaces. These fragments are flat in cross-section and have straight even edges. These attributes indicate that these pieces are fragments from either preforms or finished projectile points. Two of the chert pieces are tip fragments, one is a midsection fragment, and the third is an edge fragment. Two of the obsidian fragments are small wedge-shaped pieces broken from the edges of a biface, and the final obsidian piece is a small pointed tip fragment, most likely from a small projectile point.

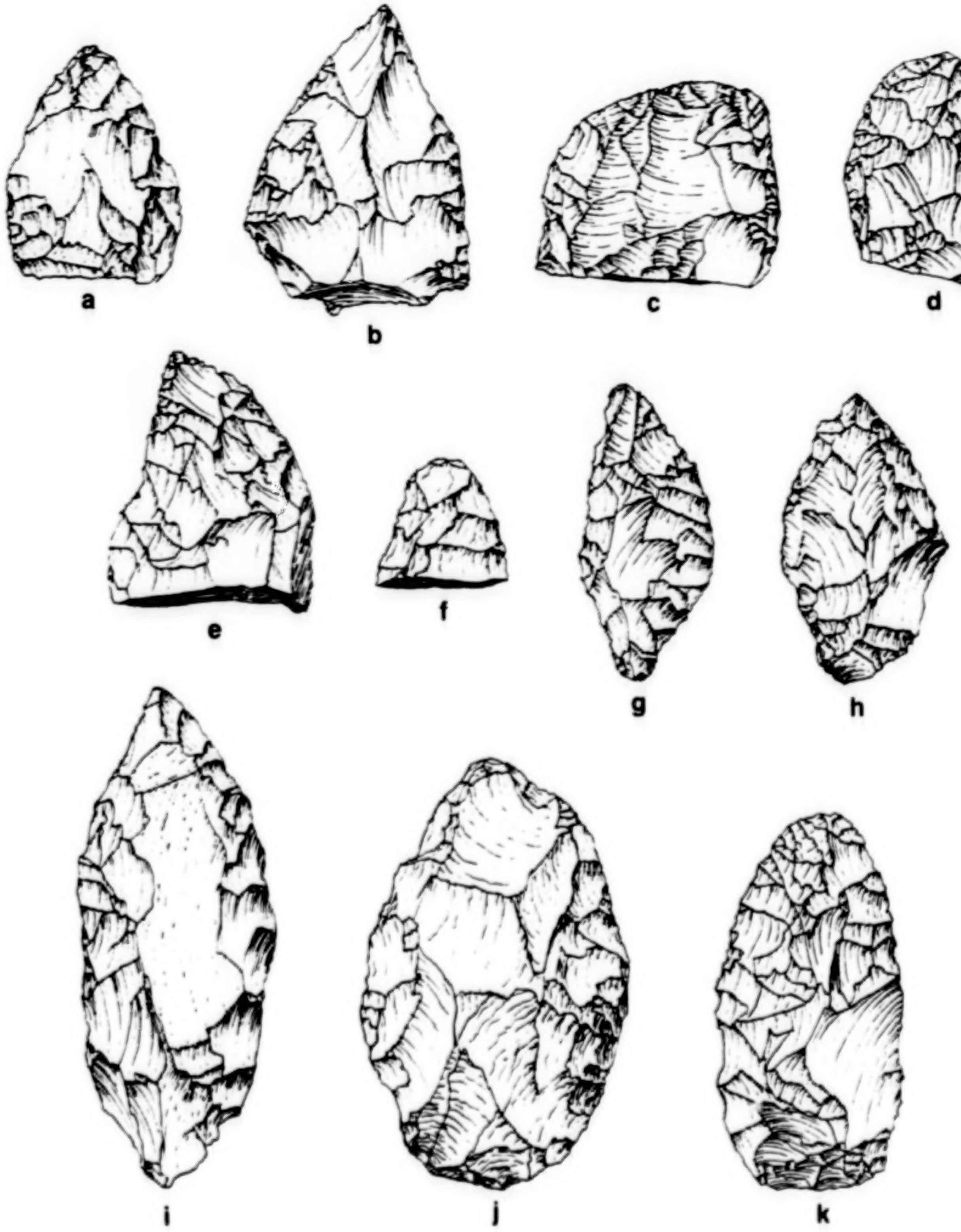

Figure 11. Mid-stage bifaces: Stage 3 (shown actual size).

a. IF-32 b. TP6-5/1-1 c. IF-9 d. IF-30 e. TP2-1/1-2
f. TP9-1/1-[illegible] g. TP13-2/1-1 h. TP11-1/1-1 i. IF-4 j. TP14-1/1-2
k. TP2-5/2-3

Preforms

Six chert bifaces have been classified as projectile point preforms (Stage 5). These preforms are very finely flaked and shaped. All of the preforms are lenticular in cross-section, with the two smaller specimens considerably flatter and thinner than the larger ones. The flake scars on both faces of all of these pieces exhibit very regular-parallel to diagonal-parallel pressure flaking. The edge margins are straight and regularized.

One preform has very straight lateral edges and is missing the distal tip (Figure 13j). This specimen has a relatively straight base, with only a slight convex rounding in the center. The other preforms have either rounded or pointed convex bases (Figure 13,k-o). These preforms are widest at the juncture of the blade section with the base element. The four larger preforms are much thicker and longer than the two smaller specimens. Based on the general morphology of the larger preforms, it appears that they were made on the larger thicker blanks, while the two smaller thinner preforms (Figure 13l,n) were made on thin flake blanks.

All of the preforms from this assemblage are finely flaked specimens only lacking notching and perhaps some final edge retouch. In fact, these preforms are as finely flaked, or more finely flaked than some of the projectile points, suggesting that these implements could have been used as projectile points without further modification. It would appear though, based on the types of projectile points recovered, that these specimens were indeed preforms and not finished points (see below for a more detailed discussion).

Projectile Points

Eight projectile points were recovered from the excavations and a single point was collected from the site surface. The projectile points have been divided into two general groups: (1) narrow-necked, and (2) broad-necked. All of the projectile points are made of chert. Neck width measurements for the six narrow-necked points range from 3.7 to 5.5 mm, with the neck widths on the three broad-necked points measuring between 7.9 and 10.6 mm (Table 3).

Narrow-necked Points: The narrow-necked points are all small corner-notched contracting stem specimens with shallow corner-notches, short rounded stems, and short barbs. Two of these small points are complete (Figure 13,a-b), while the remaining four all have broken tips (Figure 13,c-f). One of the points is also broken across the notches removing the stem (Figure 13f), and a second is broken diagonally across the base removing the stem and one barb (Figure 13c). All of the narrow-necked points display fine regularized pressure flaking across both faces, except for the specimen broken across the neck. This small point exhibits bifacial flaking only along the edges and the base,

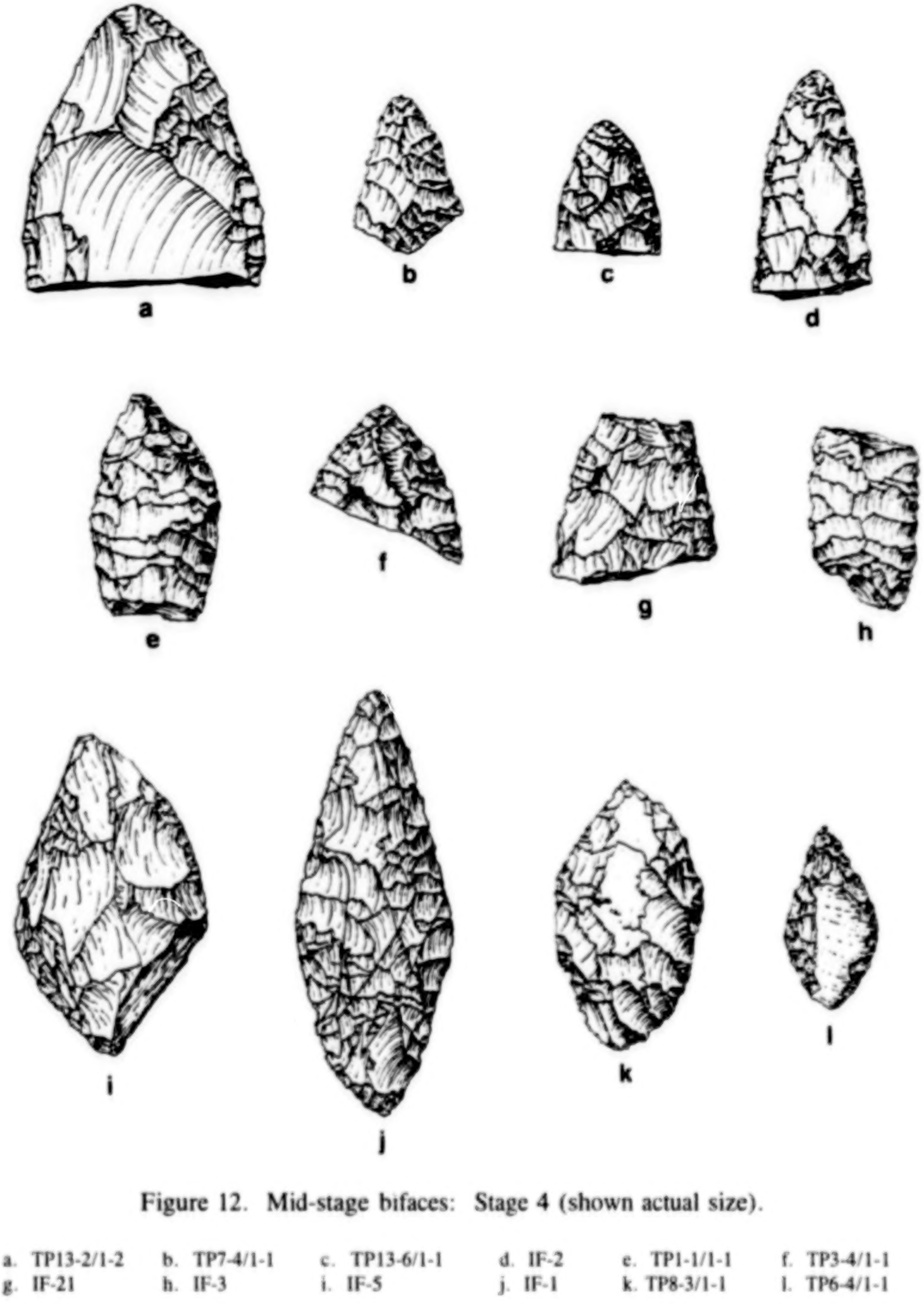

Figure 12. Mid-stage bifaces: Stage 4 (shown actual size).

a. TP13-2/1-2 b. TP7-4/1-1 c. TP13-6/1-1 d. IF-2 e. TP1-1/1-1 f. TP3-4/1-1
g. IF-21 h. IF-3 i. IF-5 j. IF-1 k. TP8-3/1-1 l. TP6-4/1-1

Table 3. Metric data for projectile points and preforms.

Specimen Number	Measurements (mm and grams)						Raw Material	Comments
	L	MW	Th	NW	BW	Wt		
Projectile Points								
IF-23	24.5	23.3	5.0	10.6	10.2	3.41	Chert	Tip Broken
TP2-5/2-1	15.8	12.3	2.7	4.7	2.1	0.38	Chert	Tip Broken
TP3-5/1-1	14.3	16.6	4.7	4.0	3.5	1.04	Chert	Tip Broken
TP3-6/2-1	38.7	15.5	5.6	7.9	11.0	3.02	Chert	Complete
TP7-5/1-1	15.0	16.0	2.4	8.6	16.0	0.71	Chert	Base Fragment
TP10-2/1-1	18.3	11.3	2.9	4.0	1.7	0.46	Chert	Complete
TP11-2/1-1	27.6	7.6	3.2	-	-	0.60	Chert	Base Broken
TP13-1/1-1	27.2	11.2	4.6	3.7	2.6	0.89	Chert	Complete
TP15-3/1-1	14.2	12.7	3.2	5.5	-	0.60	Chert	Tip/Base Broken
Preforms								
TP2-5/2-2	34.0	15.5	6.9	-	-	3.31	Chert	Tip Broken
TP3-1/1-1	31.7	16.8	6.6	-	-	3.63	Chert	Tip/Base Broken
TP4-4/1-1	39.4	15.0	6.4	-	-	3.01	Chert	Complete
TP6-7/2-1	28.5	15.3	6.3	-	15.3	3.16	Chert	Tip Broken
TP10-4/1/1	31.8	13.3	4.4	-	-	1.72	Chert	Complete
TP11-3/1-1	30.0	12.5	3.4	-	-	1.05	Chert	Complete

L = Length MW = Maximum Width Th = Thickness NW = Neck Width BW = Base Width Wt = Weight

indicating that the original flake blank was thin enough to allow only shaping of the edges and did not require primary or secondary thinning (Figure 13f). Although the narrow-necked points all appear to represent one basic form, the Gunther Series, there is considerable variation in the thickness and general outline of these small points.

Broad-necked Points: Two of the broad-necked points are large corner-notched specimens, with deep wide notches and rounded concave bases (Figure 13,h-i). The third point is also corner-notched, but with a straight stem (Figure 13g). Two of the points are broken across the blade section and the third is complete.

The complete point retains a portion of the original detachment scar on one face, as well as the curvature of the flake blank in long section. Flaking on what was the ventral surface of the flake blank is restricted to the edges and flaking on the dorsal surface, although covering the entire face, is parallel on one side of the midline and unpatterned on the other side (Figure 13i). A thick hump remains on the dorsal face, which is perhaps the reason this point was discarded.

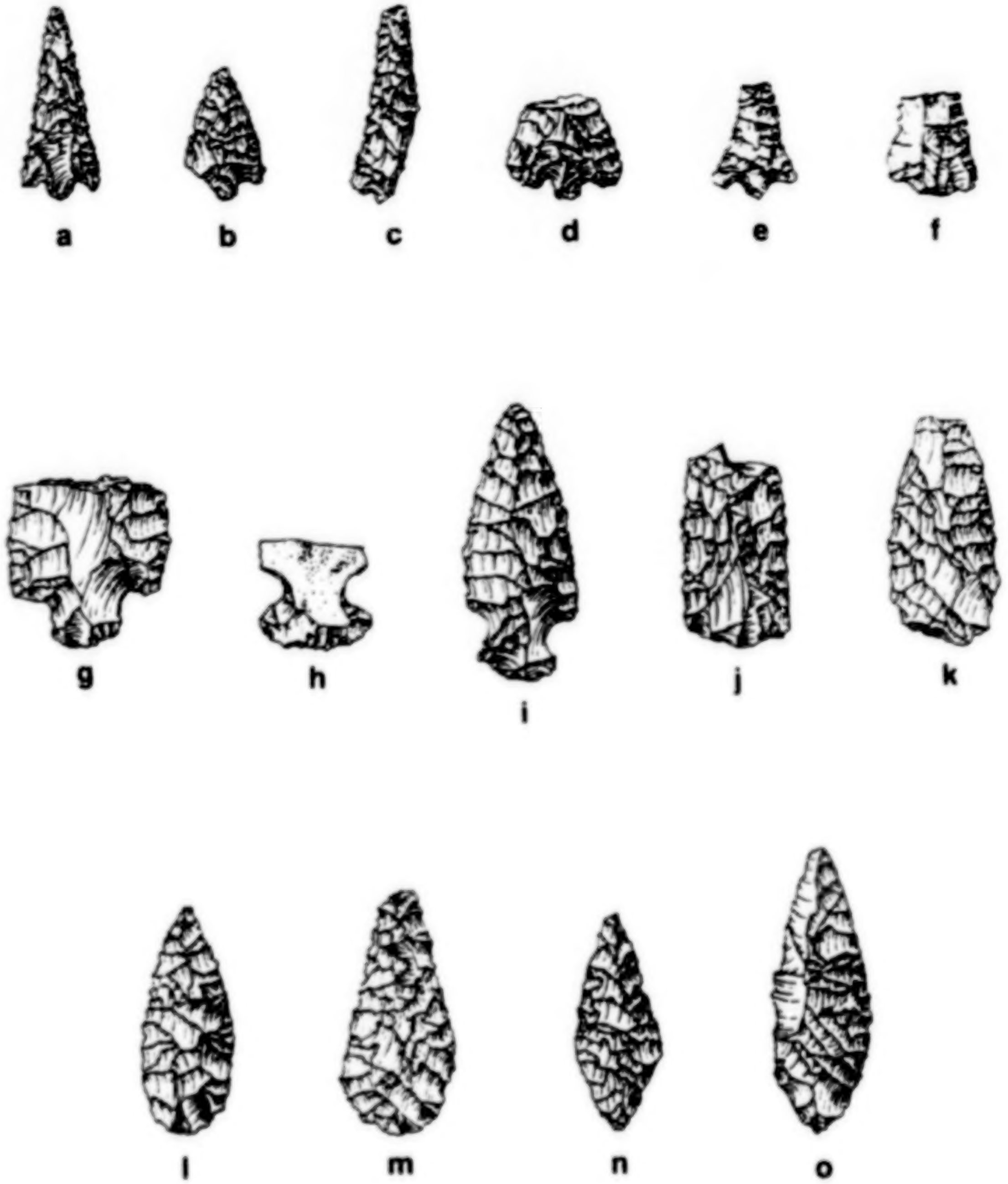

Figure 13. Projectile points and preforms: a-f, narrow-necked; g-i, broad-necked; j-o, preforms (shown actual size).

a. TP13-1/1-1 b. TP10-2/1-1 c. TP11-2/1-1 d. TP3-5/1-1 e. TP2-5/2-1
f. TP15-3/1-1 g. IF-23 h. TP7-5/1-1 i. TP3-6/2-1 j. TP6-7/2-1
k. TP3-1/1-1 l. TP10-4/1-1 m. TP2-5/2-2 n. TP11-3/1-1 o. TP4-4/1-1

The second point is a base fragment that was broken just above the notches. This point also appears to have been made on a very thin flake blank (Figure 13h), and is very close to being side-notched.

The point with the straight base also displays much of the original detachment scar on one face, as well as a small portion of the dorsal surface of the original flake blank on the other face (Figure 13g). Flaking is restricted to the edges and base on both faces and does not reach the midline on either side. Both the complete point and this point were made on thin flake blanks to which edging, shaping, and secondary thinning were applied; primary thinning was not required. This approach resulted in finished points that still retain unmodified areas of the original flake blank in the center of one or both faces.

Unifaces

A total of 47 unifacially flaked tools were recovered. A single chert endscraper was the only formed unifacial tool found. The rest of the unifacial tools were flakes that exhibited either (1) definite unifacial flaking or retouch along a portion of at least one edge (unifaces), or (2) small flake scars or nibbling, but not definite retouch (used flakes). The unifacial tools were all made on chert flakes, except for a single basalt used flake recovered from Test Pit 2 (Table 4).

The endscraper was formed on a thick chert flake by applying steep unifacial retouch on the distal end and lateral margins of the flake (Figure 14a). This retouch created a very steep rounded scraping edge that exhibits evidence of considerable crushing and step fracturing.

The unifaces and the used flakes are not formed tools, and their large size and rough appearance suggests that they may have been the products of the lithic reduction process rather than actually used for scraping or cutting tasks. As initial edging would create unifacial flake scars on the edges of flake blanks, the unifacial tools may in fact have been produced during Stage 2 biface reduction (Figure 14b-c).

COBBLE TOOLS

Thirty-six cobble tools were recovered. Twenty-three were collected from the site's surface, and 13 were recovered from the test excavations. The majority (89%) of the cobble tools were either made on flakes removed from rounded basalt cobbles or the rounded cobbles themselves were used as tools. Aside from basalt, the other lithic materials represented among the cobble tools include a very hard sandstone and what appears to be schist.

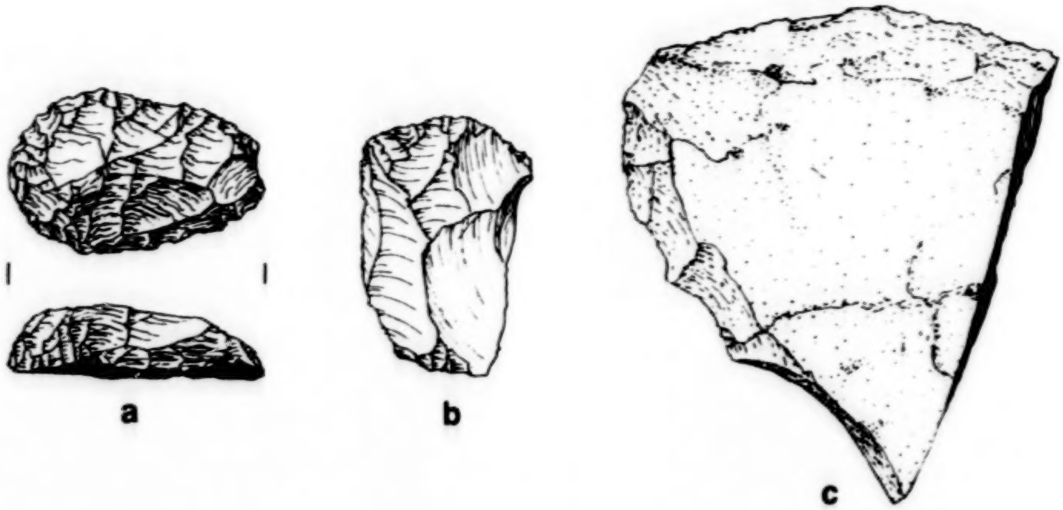

Figure 14. Unifacial tools: a, endscraper; b-c, unifaces (shown actual size).

a. TP11-5/1-3 b. TP2-3/1-4 c. TP13-3/1-1

Hammerstones

Twelve small naturally rounded and somewhat oblong cobbles all exhibit pecking and battering on at least one end (Figure 15). The battered areas are restricted to only a small area on the end of the cobbles, suggesting they were used as hard hammer percussors in the lithic reduction process. Three of the hammerstones are sandstone cobbles, while the remainder of the hammerstones are basalt cobbles.

Anvilstones

Five large cobbles and three smaller rounded cobbles all exhibit pecking on at least one flat surface. On the smaller cobbles, the pecking is restricted to a small battered area on one side, and this pecking has created a depression (Figure 16). The larger cobbles show evidence of pecking or battering across at least one flat surface, giving them a pock-marked appearance (Figure 17). These cobbles are interpreted to have been anvils on which the nodules split by bipolar percussion were placed, thus producing the battering on flat surfaces observed on these specimens.

Table 4. Metric attributes of the endscraper, unifaces, and used flakes.

Specimen Number	Measurements (mm and grams) Length	Width	Thickness	Weight	Raw Material	Comments
Endscraper						
TP11-5/1-3	32.4	21.6	8.9	6.62	Chert	Complete Flake
Unifaces						
IF-31	42.8	28.1	6.3	18.08	Chert	Complete Flake
IF-46	61.3	41.9	19.7	33.68	Chert	Complete Flake
TP2-3/1-4	33.5	22.7	5.7	4.20	Chert	Complete Flake
TP2-3/1-5	48.9	48.2	10.0	17.48	Chert	Flake Fragment
TP3-1/1-2	20.0	19.0	10.1	2.32	Chert	Flake Fragment
TP3-3/1-3	40.8	31.8	17.2	13.30	Chert	Flake Fragment
TP3-3/1-4	58.6	44.6	14.0	38.21	Chert	Flake Fragment
TP4-2/1-3	26.0	32.3	10.0	7.41	Chert	Broken Flake
TP4-2/1-4	68.4	40.2	11.2	30.15	Chert	Flake Fragment
TP4-4/1-4	31.8	24.0	12.2	7.98	Chert	Flake Fragment
TP6-1/1-1	27.6	9.0	3.7	0.76	Chert	Flake Fragment
TP6-3/1-1	31.7	23.4	4.0	2.26	Chert	Flake Fragment
TP6-4/1-2	27.1	13.8	6.7	2.20	Chert	Flake Fragment
TP9-4/1-2	57.5	54.3	20.3	39.99	Chert	Complete Flake
TP10-2/1-3	26.3	21.8	8.7	3.46	Chert	Flake Fragment
TP10-4/1-2	25.3	22.9	7.7	3.95	Chert	Flake Fragment
TP12-1/1-2	38.0	22.5	10.2	9.33	Chert	Flake Fragment
TP13-1/1-2	37.3	30.2	11.6	12.82	Chert	Broken Flake
TP13-3/1-1	55.4	61.3	10.7	43.00	Chert	Flake Fragment
TP13-4/1-1	33.2	33.4	6.0	7.55	Chert	Flake Fragment
TP14-4/1-1	57.0	45.6	14.7	32.49	Chert	Flake Fragment
TP14-7/2-2	58.6	54.4	21.5	66.54	Chert	Complete Flake
Used Flakes						
TP2-3/1-3	66.5	45.3	13.8	39.84	Basalt	Complete Flake
TP4-5/1-1	30.3	17.9	4.7	1.87	Chert	Flake Fragment
TP6-6/1-2	35.1	32.5	7.6	6.30	Chert	Flake Fragment
TP6-7/2/2	52.3	40.4	11.2	21.96	Chert	Complete Flake
TP7-6/1-1	16.9	7.4	4.4	0.57	Chert	Flake Fragment
TP7-4/1-2	30.6	30.1	13.5	9.10	Chert	Complete Flake
TP10-2/1-5	62.3	40.5	10.1	23.35	Chert	Complete Flake
TP11-7/2-1	27.2	22.2	6.7	3.40	Chert	Complete Flake
TP15-3/1-2	59.3	28.9	13.0	18.05	Chert	Complete Flake

Table 5. Metric attributes for hammerstones, flaked cobbles, battered cobbles, and anvilstones.

Specimen Number	Measurements (mm and grams)				Raw Material
	Length	Width	Thickness	Weight	
Hammerstones					
IF-18	74.2	50.0	45.0	244.51	Basalt
IF-19	123.3	56.7	48.7	538.42	Basalt
IF-27	84.2	61.1	43.3	329.18	Basalt
IF-36	93.2	52.8	36.3	268.23	Basalt
IF-39	170.0	66.7	64.6	1222.40	Basalt
IF-40	93.0	44.3	34.2	211.20	Basalt
IF-43	11.6	45.5	39.3	298.74	Basalt
TP2-1/1-5	56.7	51.8	19.8	75.05	Sandstone
TP4-3/1-1	46.3	62.7	30.7	105.40	Basalt
TP6-1/1-3	64.9	57.7	26.8	162.84	Sandstone
TP6-3/1-2	60.2	49.2	26.2	109.28	Sandstone
TP10-3/1-3	99.1	64.8	29.5	289.39	Basalt
Anvilstones					
IF-8	138.0	112.7	75.0	1798.00	Basalt
IF-12	194.0	153.0	66.3	3225.00	Basalt
IF-15	227.0	105.0	51.5	2487.00	Basalt
IF-16	86.6	74.0	53.9	479.91	Basalt
IF-38	89.0	55.9	28.6	240.19	Schist
TP13-4/1-2	355.0	99.2	70.3	4089.00	Basalt
TP14-3/1-1	276.0	150.0	96.2	4035.00	Basalt
TP14-5/1-1	108.0	69.7	54.8	471.98	Basalt
Battered Cobble					
TP9-1/1-2	11.10	68.6	37.8	421.44	Basalt
Flaked Cobbles					
IF-10	111.02	96.5	61.8	875.95	Basalt
IF-20	72.9	46.5	21.6	104.63	Basalt
IF26	109.5	54.1	20.3	209.16	Basalt
IF-34	101.0	64.9	20.7	207.89	Basalt
TP2-3/1-7	81.9	76.0	19.1	133.01	Basalt
TP3-3/1-5	91.4	89.0	40.6	344.33	Basalt
TP10-3/1-5	78.4	46.2	25.7	76.10	Basalt
TP11-4/1-1	200.5	133.0	48.2	1643.00	Basalt
Flaked Spalls					
IF-22	96.9	64.8	13.5	103.54	Basalt
IF-25	112.7	71.8	16.2	162.70	Basalt
IF-28	94.9	77.4	14.0	106.00	Basalt
IF-35	118.2	91.4	25.8	253.20	Basalt
IF-41	125.2	71.8	17.1	161.30	Basalt
IF-42	100.5	90.9	17.2	172.71	Basalt
IF-45	110.3	99.0	22.7	249.22	Basalt

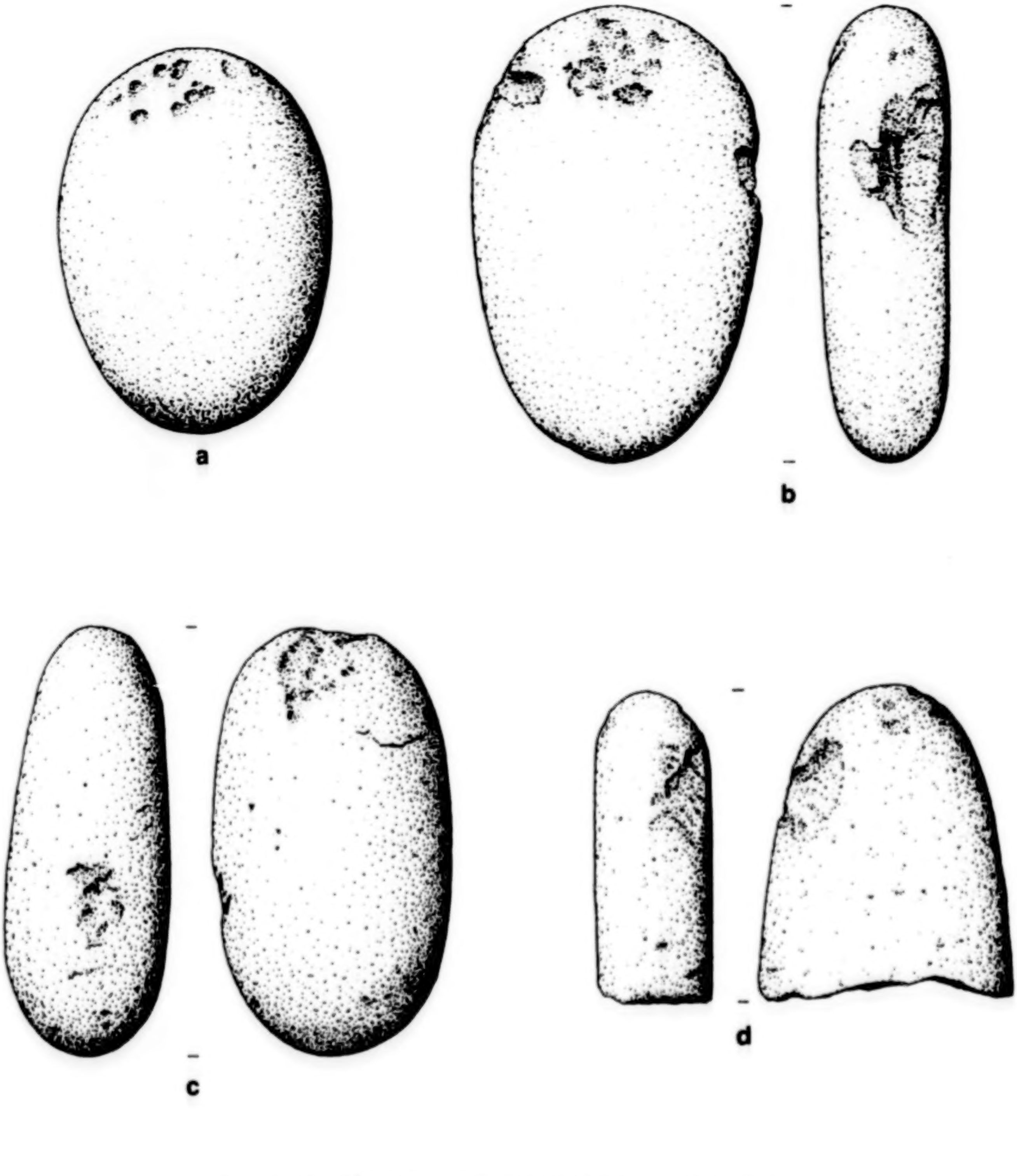

Figure 15. Hammerstones (shown 75% of actual size).

a. IF-27 b. TP10-3/1-3 c. IF-36 d. TP6-1/1-3

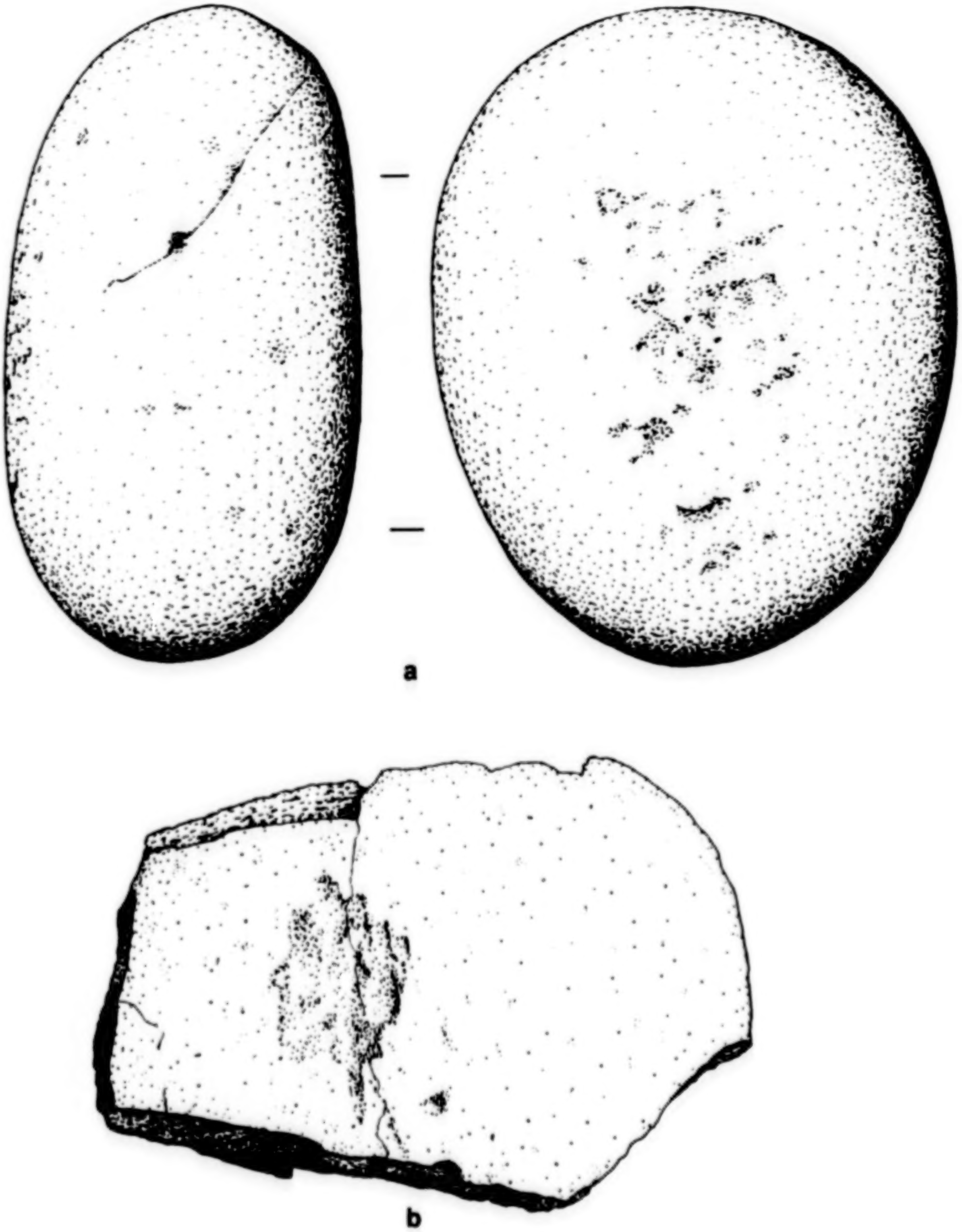

Figure 16. Anvilstones: a, IF-8; b, TP14-5/1-1 (shown 50% of actual size).

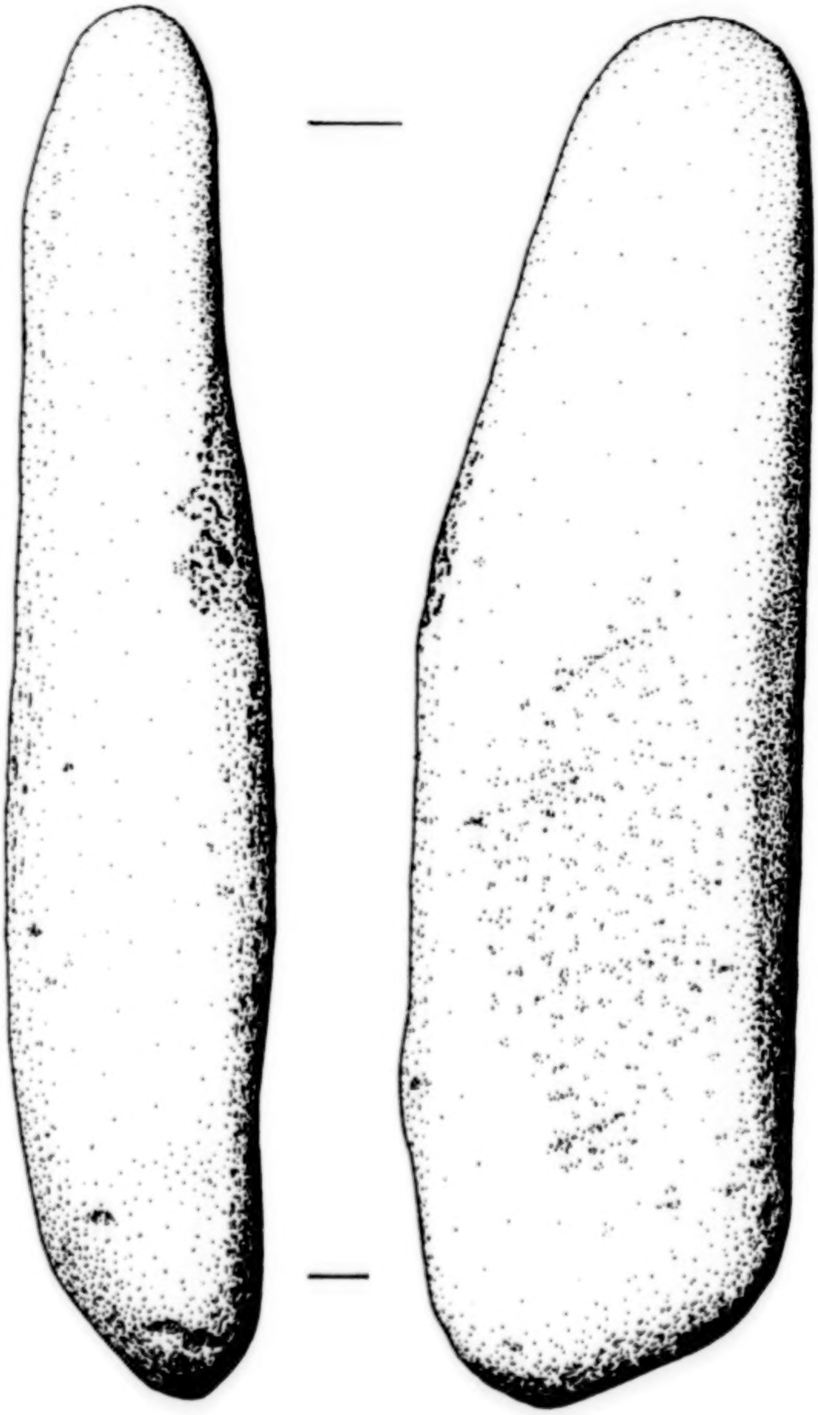

Figure 17. Anvilstone (TP13-4/1-2; shown 50% of actual size).

Battered Cobble

A single angular cobble was recovered that exhibits heavy battering on the squared edges of the implement. This piece may also have been used as a hammerstone for splitting nodules.

Flaked Cobbles

Eight rounded cobbles display unpatterned flake scars on their surface or along a fracture face. None of the flaked cobbles were formed into tools, such as choppers. Instead, these specimens appear to be simply cobbles from which flakes have been removed. These flaked cobbles are undoubtedly the material from which the few basalt flakes recovered from the site were produced.

Flaked Spalls

Seven large basalt heat spalls were recovered from the site's surface (Table 5). The edges of these spalls all show evidence of some type of modification, but not definite flake scars. A number of large heat spalls were also noted during the excavations, but they did not show evidence of edge alteration like those from the surface and were not collected. The nature of the modification to the heat spalls from the surface suggests that these items may have been used as cutting or scraping tools, although the edges may also have been damaged by trampling or other natural causes.

CLAY PIPE STEM

A small fragment of a clay pipe stem was recovered from level 1 in Test Pit 11. This piece is a hollow cylinder measuring 28.0 mm in length (Figure 18). The stem tapers slightly with a maximum diameter at one end of 15.3 mm and 14.9 mm at the other end. The central hole has a diameter of 6.4 mm. The exterior of the pipe stem has been smoothly polished and appears to be finely made.

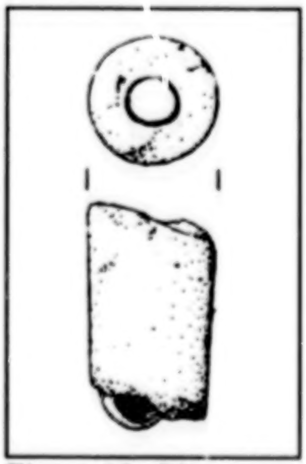

Figure 18. Pipe stem.
TP11-1/1-3

IV. ANALYSIS OF FLAKED STONE DEBITAGE

A total of 19,339 pieces of flaked stone debitage were recovered from the Bravo Creek Site. Of that total, 11 pieces were collected from the surface of the site, and the remaining 19,328 flakes were recovered from the excavation units. The debitage assemblage is dominated by chert flakes. Of the total debitage recovered, 18,615 (96.26%) are chert flakes, 716 (3.7%) are obsidian flakes, and only eight (0.04%) are basalt flakes (Appendix A).

ANALYTICAL METHODS

Beyond tabulation of the debitage by raw material, a more intensive analysis was conducted on a selected sample from the excavation units. Due to the large number of chert flakes recovered during the excavations a sampling strategy was employed to select a smaller assemblage for analysis. The analytical sample was designed to include all of the flakes from a single 1 x 1 m test unit in each of the larger excavation blocks. The use of this sampling design resulted in the analysis of all of the chert flakes from Units 2, 4, 6, 8, and 10. Because the number of obsidian flakes recovered was so small in comparison to the chert debitage, it was decided to include all of the obsidian debitage recovered from the test excavations in the analytical sample. None of the flakes collected from the site surface (including one obsidian and 10 chert flakes) or any of the basalt debitage were included in the analytical sample.

A total of 7867 flakes or 40% of the total debitage assemblage was selected as the analytical sample. The sample assemblage consisted of 7151 (90.90%) chert flakes and 715 (9.10%) obsidian flakes (Table 6).

The analysis of the sample assemblage was divided into two stages: an initial descriptive stage that included all of the flakes from the analytical sample, and a subsequent technological stage that was conducted only on those flakes that retained a striking platform. A total of 1484 (20.75%) chert flakes and 421 (58.88%) obsidian flakes from the sample assemblage retained a striking platform (Table 7).

The descriptive stage of analysis entailed the classification of all of the flakes by flake type, presence or absence of cortex, and flake size (Table 6). The technological analysis (Table 7) was structured to characterize each platform-bearing flake, based on

Table 6. Summary of the debitage from the analytical sample by raw material.

	Obsidian		Chert		Total	
Analytical Category	n	%	n	%	n	%
Flake Type						
Complete	304	42.52	1239	17.00	1543	19.61
Broken	117	16.36	245	3.43	362	4.60
Fragment	292	40.84	4212	58.90	4505	57.26
Debris	2	0.28	1455	20.35	1457	18.52
Cortex						
Primary	-	-	45	0.63	45	0.57
Secondary	-	-	942	13.17	942	11.98
Interior	715	100.00	6164	86.20	6880	87.45
Flake Size						
0-5 mm	164	22.94	277	3.87	441	5.61
5-10 mm	509	71.19	1892	26.46	2402	30.53
10-20 mm	40	5.59	2913	40.74	2953	37.54
20-30 mm	2	0.28	1134	15.86	1136	14.44
30-40 mm	-	-	495	6.92	495	6.29
40-50 mm	-	-	237	3.31	237	3.01
50-60 mm	-	-	110	1.54	110	1.40
60-70 mm	-	-	53	0.74	53	0.67
70-80 mm	-	-	24	0.34	24	0.31
80-90 mm	-	-	11	0.15	11	0.14
90-100 mm	-	-	5	0.07	5	0.06
TOTAL	715	9.09	7151	90.91	7866	100.00

attributes of striking platform morphology, platform preparation, and the identification of distinctive technological flake types (Musil and Connolly 1991).

Flake Type

The flake type category incorporates four mutually exclusive debitage categories as defined by Sullivan and Rozen (1985:759). The *complete* category includes all flakes that retain a striking platform and are not otherwise damaged. *Broken* flakes are those flakes that retain a striking platform, but are broken in some manner. Both broken and complete flakes also have a discernible single interior surface. Flake *fragments* are also broken flakes, but in contrast to the *broken* category these specimens do not retain the striking platform. Like *broken* and *complete* flakes, *fragments* also have a single interior surface. The *debris* category includes all flakes that do not have a discernible single interior surface or a striking platform. In general, the debris category encompasses the commonly used categories of *angular waste* and *shatter*.

Sullivan and Rozen (1985:774) have demonstrated that the proportions of these type categories vary between sites, and they have suggested that assemblage variability is related to functional and organizational factors. Research has shown that variability does exist between debitage assemblages, in assemblages recovered from both experimental and archaeological contexts. However, the distinctions made have been rather general, and for the most part are only able to distinguish between core reduction and tool production (Prentiss and Romanski 1989; Sullivan 1987; cf. Mauldin and Amick 1989).

Cortex

Each of the flakes was examined for the presence or absence of cortex. Flakes that exhibited complete cortical coverage of the dorsal surface were defined as *primary* cortex flakes and flakes that retained some, but less than 100% cortex on their dorsal surface, were classed as *secondary* cortex flakes. Flakes that lacked cortex were defined as *interior* flakes.

Flakes exhibiting cortex (especially primary cortex) are indicators of the earliest stages of lithic reduction (in particular core reduction). As the reduction process continues the number of cortex-covered surfaces decreases rapidly, resulting in fewer flakes with secondary cortex and a predominance of interior flakes (Ahler 1989a:90; Fish 1981:379; Mauldin and Amick 1989:69-71; Tomka 1989:141-143).

Flake Size

Each flake was measured using a target of concentric circles divided in increments of 0-5 mm and 5-10 mm through 90-100 mm (Table 6). This method provides a measurement of the maximum dimension of each flake to within either 5 or 10 mm.

The lithic reduction process is subtractive, and results in a systematic decrease in the size of the flakes produced from the initial stages of core reduction through the final stages of tool manufacture. Patterns in the size distribution of lithic debris have previously been used as a method of distinguishing the stages of lithic reduction (Ahler 1989a; Neumann and Johnson 1979; Newcomer 1971; Stahle and Dunn 1982). It has also been pointed out that the size of flakes recovered at a site will be affected by the size of the parent material being reduced and the stage(s) of reduction represented at a site (Mauldin and Amick 1989; Baumler and Downum 1989).

Platform Morphology

Each of the platform bearing-flakes was classified as to the morphology of the striking platform. Four general categories of platform morphology were observed in the assemblage: (1) *cortex*, (2) *crushed* platforms, (3) *unfaceted* platforms, and (4) *faceted* platforms. The cortex category consists of flakes that retain cortex on the striking platform (Chapman 1977:378; Schneider 1972:94; Tomka 1989:148). On flakes with crushed platforms much of the bulb of force is retained, but the surface of the striking platform has collapsed or been pulverized immediately below the point of impact by the application of excessive force (Hayden and Hutchings 1989:240; Patterson 1983:300; Schneider 1972:94). Flakes with unfaceted platforms have a single or plain unfaceted striking surface, while complex faceted platforms display one or multiple facets indicative of the flake being removed from a previously worked edge (Chapman 1977:378; Frison and Bradley 1980:27; Raymond 1989:84; Shafer 1985:294).

Table 7. Summary of the flakes with striking platforms by raw material.

	Obsidian		Chert		Total	
Analytical Category	n	%	n	%	n	%
Platform Morphology						
Cortex	-	-	262	17.65	262	13.75
Crushed	1	0.24	12	0.81	13	0.69
Unfaceted	2	0.48	633	42.65	635	33.33
Faceted	418	99.29	577	38.89	995	52.23
Platform Preparation						
Ground	4	0.95	-	-	4	0.21
Reduced	12	2.85	11	0.74	23	1.21
Single Removal	32	7.60	11	0.74	43	2.26
Multiple Removal	52	12.35	7	0.47	59	3.09
Unprepared	321	76.25	1455	98.05	1776	93.23
Distinctive Flake Type						
Primary Decortication	-	-	23	1.55	23	1.21
Alternate	10	2.38	-	-	10	0.52
Multiple Secondary	-	-	7	0.47	7	0.37
Biface Edge Removal	7	1.66	19	1.28	26	1.36
Bifacial Thinning	129	30.64	101	6.81	230	12.07
Late Stage Pressure	129	30.64	38	2.56	167	8.77
Normal	146	34.68	1296	87.33	1442	75.70
TOTAL	421	22.10	1484	77.90	1905	100.00

Platform Preparation

Each of the platform-bearing flakes was examined for the presence or absence of intentional preparation on the dorsal edge of the striking platform. Platform preparation was undertaken as an attempt by the flintknapper to control the direction and morphology of the flake being removed. If a striking platform did not provide the proper configuration, various techniques could be applied to the dorsal margin of the striking platform to help predetermine the characteristics of the as yet unattached flake. Platform preparation was applied to dull and strengthen the striking surface, to position the placement of the platform, and to change the platform's angle of bevel. Platform preparation is thought to have been more commonly employed during the later stage of tool manufacture when controlled flake removal is critical in the production of a finished implement (Callahan 1979:34; Crabtree 1972:34; Frison and Bradley 1980:27; Patterson 1983:302; Schneider 1972:94-95).

Four types of platform preparation were observed: (1) platform *grinding*, (2) *reduced* platforms, (3) platforms with *single* flake removals, and (4) platforms with *multiple* flake removals. Platform grinding removes thin and weak edges and rounds and strengthens the platform edge (Crabtree 1972:12; Tomka 1989:148). Reduced platforms have severely abraded dorsal edges that exhibit small step fractures on the dorsal margin of the platform, presumably from the use of a rough stone to abrade the striking platform, changing the angle of the bevel and strengthening the edge (Frison and Bradley 1980:29). The single and multiple flake removal categories record the presence of small flake removals from the dorsal margin of the striking platform. Many of the flakes did not show evidence of platform preparation, and thus an *unprepared* category was also included in the analysis.

Distinctive Flake Types

In addition to examining each of the platform-bearing flakes for attributes of platform morphology and preparation, certain distinctive types of flakes were identified. These flakes are considered by researchers to be representative of particular stages of lithic reduction, and thus provide technological information important to an understanding of the reduction process at a site.

> **Primary Decortication:** Primary decortication flakes are the first flakes struck off a nodule (White 1963:5). In this study they differ from primary cortex flakes in that they are distinctive large thick flakes that remove large portions of the parent nodule. The dorsal surface and striking platform of these flakes are generally covered by cortex, but sometimes they do not exhibit complete coverage.

Alternate: Alternate flakes are produced as a result of removing flakes alternately from face to face to produce a bifacial edge from a squared edge. This flaking technique results in one edge of the flake removing and retaining a portion of the squared edge, and often exhibiting a thick triangular cross-section (Callahan 1979:34; Flenniken 1987:52; Raymond 1989:93)

Multiple Secondary: These flakes exhibit "direct superposition of positive and negative bulbs of percussion on the interior and exterior flake surfaces respectively" (Jelinek et al. 1971:98). These flakes were produced either by striking a single blow removing a pair of superimposed flakes or by striking the same platform area of the parent material twice. Flat unfaceted striking platforms are associated with this flake type.

Biface Edge Removal: These flakes remove a portion of the biface edge when the piece is struck too far in from the edge margin. The flake retains a portion of the biface edge at the proximal end and is heavily-lipped (Flenniken 1987:53; Raymond 1989:101).

Bifacial Thinning: These thin flakes are longer than they are wide, and are curved or twisted in long-section. They have multiple unidirectional or bidirectional flake scars on their dorsal surface and feathered distal terminations (Ahler 1989b:210: Flenniken 1987:53-54; Frison and Bradley 1980:24; Newcomer 1971:88)

Late Stage Pressure: These small flakes are produced during the final pressure-shaping stage of the reduction process. These flakes are small and thin and are slightly curved in long section. They are distinguished from Early Stage Pressure flakes by the presence of parallel-sided lateral margins. The dorsal surface has a single dorsal ridge or arris that is also parallel to the lateral margins (Flenniken 1987:54; Raymond 1989:103).

Normal: Flakes in this catch-all category do not exhibit attributes that would identify them as diagnostic of the other eight categories. Normal flakes are not diagnostic to a particular technological stage, but may have been produced during any stage of the reduction process (Frison and Bradley 1980:24-26).

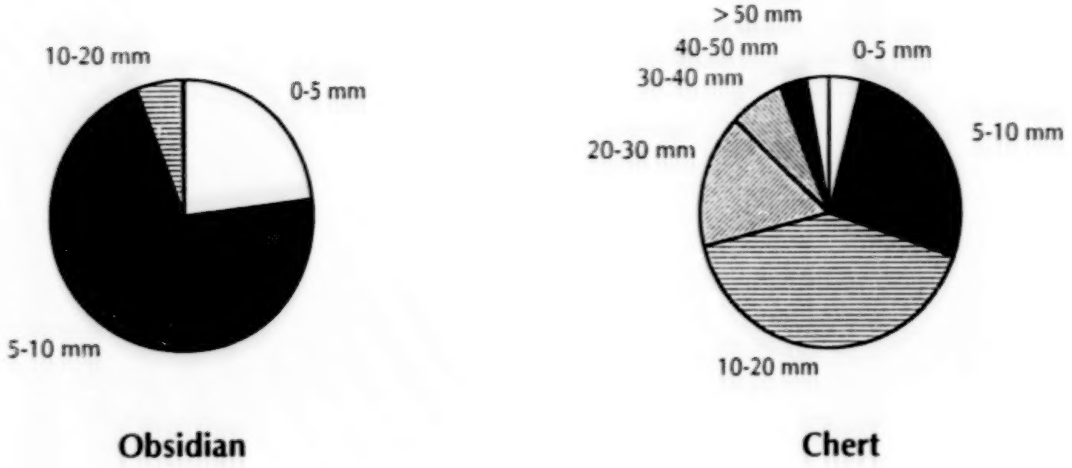

Figure 19. Percentage of flake size by raw material.

ANALYTICAL RESULTS

Obsidian

The obsidian debitage consists almost entirely of small thin flakes that do not retain cortex. All of the obsidian flakes measure less than 30 mm in maximum dimension and the majority (94.13%) measure less than 10 mm in maximum diameter (Figure 19). Only two obsidian flakes measured more than 20 mm. Given the small size of the obsidian debitage it is not unexpected that all of the flakes recovered were interior flakes (Table 6).

A majority (58.88%) of the obsidian flakes are either complete or broken flakes that retain a striking platform, although just over 40% are flake fragments. As is common with obsidian debitage, very few pieces of angular debris were recovered (Table 6).

Of the obsidian flakes that retain a striking platform almost all (99.29%) exhibit faceted platforms. Only two flakes have unfaceted platforms and a single piece exhibits a crushed platform (Table 7). Although a majority (76.25%) of the obsidian flakes have unprepared striking platforms, almost one quarter of those recovered exhibit some form of platform preparation (Table 7). Of those flakes that display platform preparation, nearly 50% exhibit multiple preparation removals, with single removals, reduced platforms, and ground platforms making up the remaining preparation types (Table 7).

Of the 421 obsidian flakes with striking platforms, just over 65% were classified as distinctive flake types, with the remainder identified as normal flakes. Equal numbers of flakes were classified as bifacial thinning and late stage pressure thinning flakes, with a few biface edge removal and alternate flakes also identified in the assemblage (Table 7).

The technologically-distinctive flake types identified in the obsidian assemblage are all products of bifacial reduction or the trimming and resharpening of damaged tools. The biface thinning, biface edge removal, and late stage pressure flakes all attest to the thinning and shaping of small bifacial implements. The small alternate flakes recovered suggest that squared edges, such as on flake blanks or broken bifacial tools, were being reworked.

Although all of the obsidian flakes are relatively small, flake size is correlated with individual distinctive flake type classes. Flakes measuring between 10 and 30 mm are dominated by bifacial thinning flakes, while the majority of flakes measuring less than 5 mm are normal flakes. Flakes measuring between 5 and 10 mm are almost

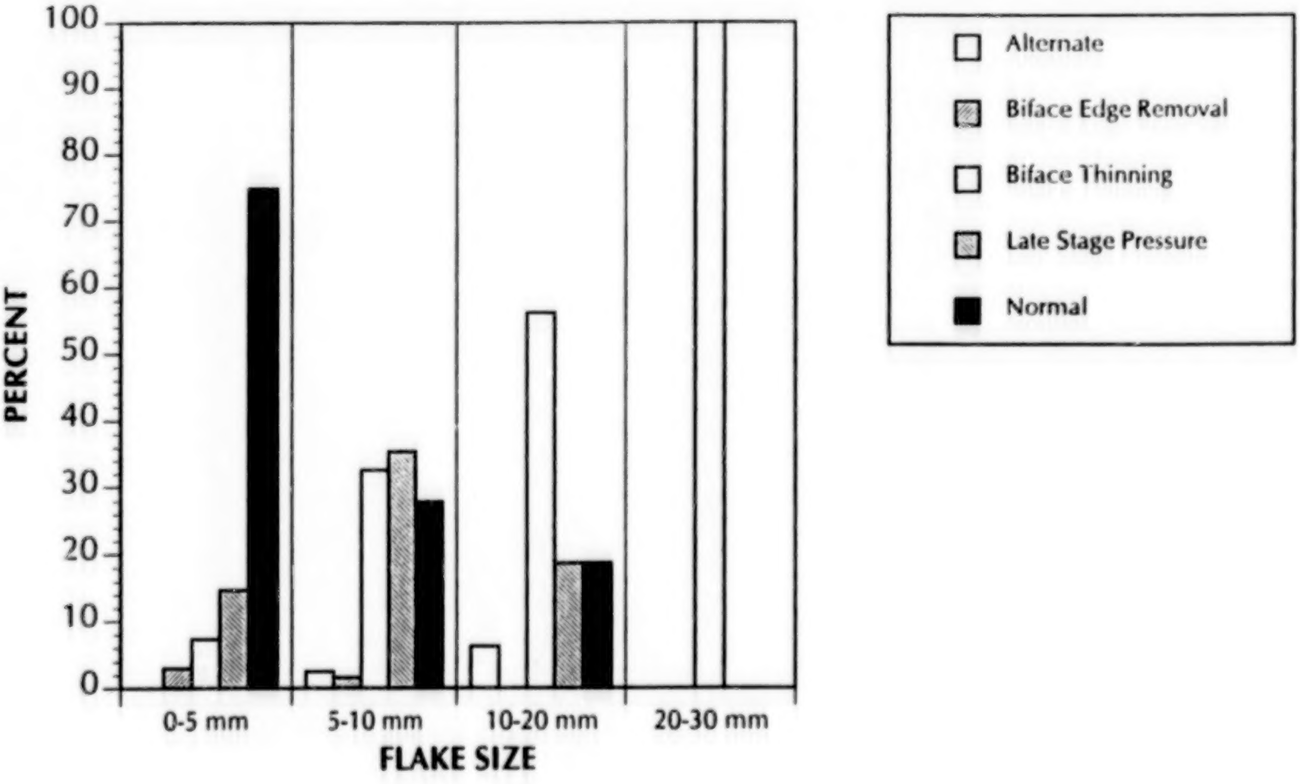

Figure 20. Percentage of technologically distinctive flake types by flake size for the obsidian debitage.

equally divided between all three of the above technological types (Figure 20). All of the biface edge removal flakes measure between 0 and 10 mm and the alternate flakes measure between 5 and 20 mm in maximum diameter.

The differences in flake size, as that dimension relates to technological flake types, are not unexpected because the attributes that define each flake type are often correlated with the size of the flake produced. Late stage pressure thinning flakes by definition are some of the smallest flakes in the assemblage and in general they should be smaller than bifacial thinning flakes. The size of alternate and biface edge removal flakes should be correlated with the size of the tools from which they were removed. By definition normal flakes can be any size, but they often are the dominant flake type among flakes measuring less than 5 mm. Flakes making up this small size class are often small circular or oval pieces that are too small to show the physical attributes that define the other technological flake types. Mechanical and physical limitations of both the flaking and analytical process often limit these very small flakes to the normal category.

Chert

The chert debitage is vastly different from the obsidian debitage recovered from the site. The chert debitage is characterized by large thick flakes and pieces of angular debris, many exhibiting cortex. The chert flakes range in size from less than 5 mm to 100 mm in maximum diameter (Table 6). A majority (83.06%) of the chert flakes measure between 5 mm and 30 mm, with only 3.87% measuring less than 5 mm. In contrast to the obsidian debitage a number of the chert flakes (13.07%) are quite large, measuring more than 30 mm (Figure 19).

The chert flakes also contrast with the obsidian debitage in the number of flakes that retain cortex (Table 6). Just under 14% of the chert flakes retain cortex, with a total of 45 flakes exhibiting primary cortex. Flake size and the presence of cortex are highly correlated, with a majority of the flakes that measure under 40 mm not retaining cortex, and a majority of those measuring greater than 40 mm retaining at least some cortex. The cortex and flake size data clearly show that as flake size decreases the presence of cortex also decreases and vice versa (Figure 21). This is a pattern that is expected in the lithic reduction process and is reflected quite well in the chert debitage from this site. Almost all of the primary cortex flakes are larger than 40 mm, but they are not the largest flakes recovered.

Unlike the obsidian debitage, a majority (58.9%) of the chert flakes are flake fragments, with flakes retaining a striking platform accounting for only about 20% of the total. In addition, angular debris totals over 20%, which is a much higher percentage than was noted for the obsidian (Table 6).

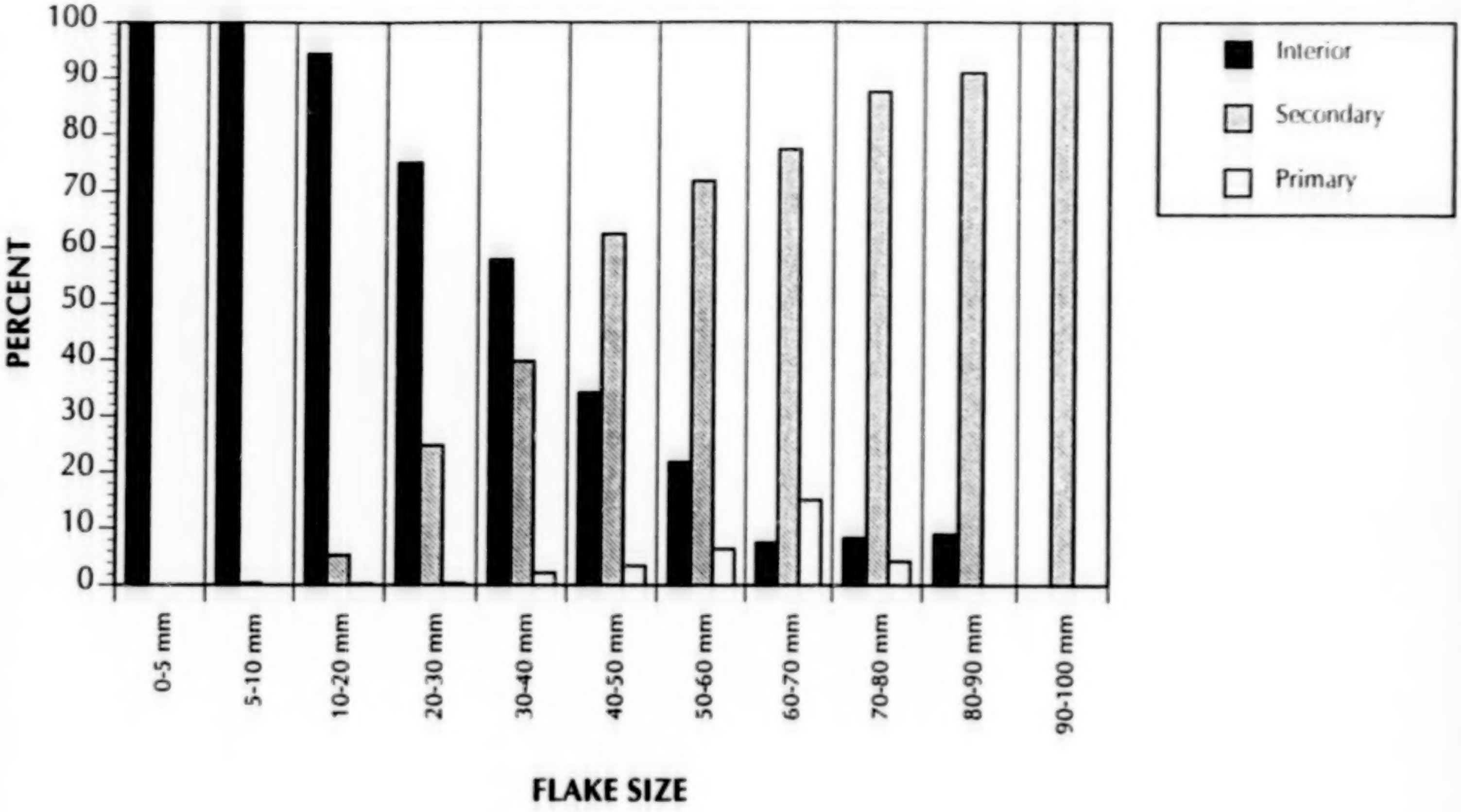

Figure 21. Percentage of cortex for each flake size class for the chert debitage.

Chert flakes that retain a striking platform also differ markedly from the obsidian debitage. In contrast to the obsidian debitage, which is dominated by flakes with faceted striking platforms, the chert assemblage contains flakes with faceted and unfaceted platforms in almost equal numbers, and nearly 18% of the chert flakes retain cortex on their striking platforms (Table 7). Only a few of the chert flakes exhibit crushed platforms.

Flake size and platform morphology are also correlated, much in the same manner that flake size and the presence of cortex are correlated. As the size of the chert flakes decreases the percentage of flakes with faceted platforms increases, to a point where all of the flakes measuring less than 5 mm have faceted platforms. This pattern is offset by the opposite trend, where as the size of the flakes increase there is a corresponding decrease in the percentage of flakes with faceted platforms and an increase in the percentage of flakes with unfaceted platforms, as well as an increase in the percentage of flakes that retain cortex on their striking platforms (Figure 22). The percentages of flakes with unfaceted platforms increases as flake size increases from 5 to 30 mm and then levels off or declines on flakes measuring between 30 and 80 mm. The percentages of flakes that retain cortex on their striking platforms also increase as flake size increases, to a point where all of the flakes measuring between 80 and 100 mm have cortex-covered platforms.

Very few (1.95%) of the chert flakes display any evidence of platform preparation. Those flakes that are prepared exhibit reduced platforms and single and multiple preparation removals in almost equal numbers (Table 7). All of the flakes with platform preparation measure under 50 mm and most (93%) are interior flakes. A majority (76%) of the flakes that have platform preparation have faceted platforms, and over half (55%) of those are bifacial thinning flakes.

A majority (87.33%) of the chert flakes were not identified to a specific technological flake type and thus were placed in the normal category. Technological flake types identified in the assemblage included primary decortication, multiple secondary, biface edge removal, bifacial thinning, and late stage pressure flakes (Table 7). Bifacial thinning, biface edge removal, and late stage pressure flakes account for just over 84% of the technological flake types, not including the normal category. These technological types are products of bifacial thinning, while primary decortication flakes

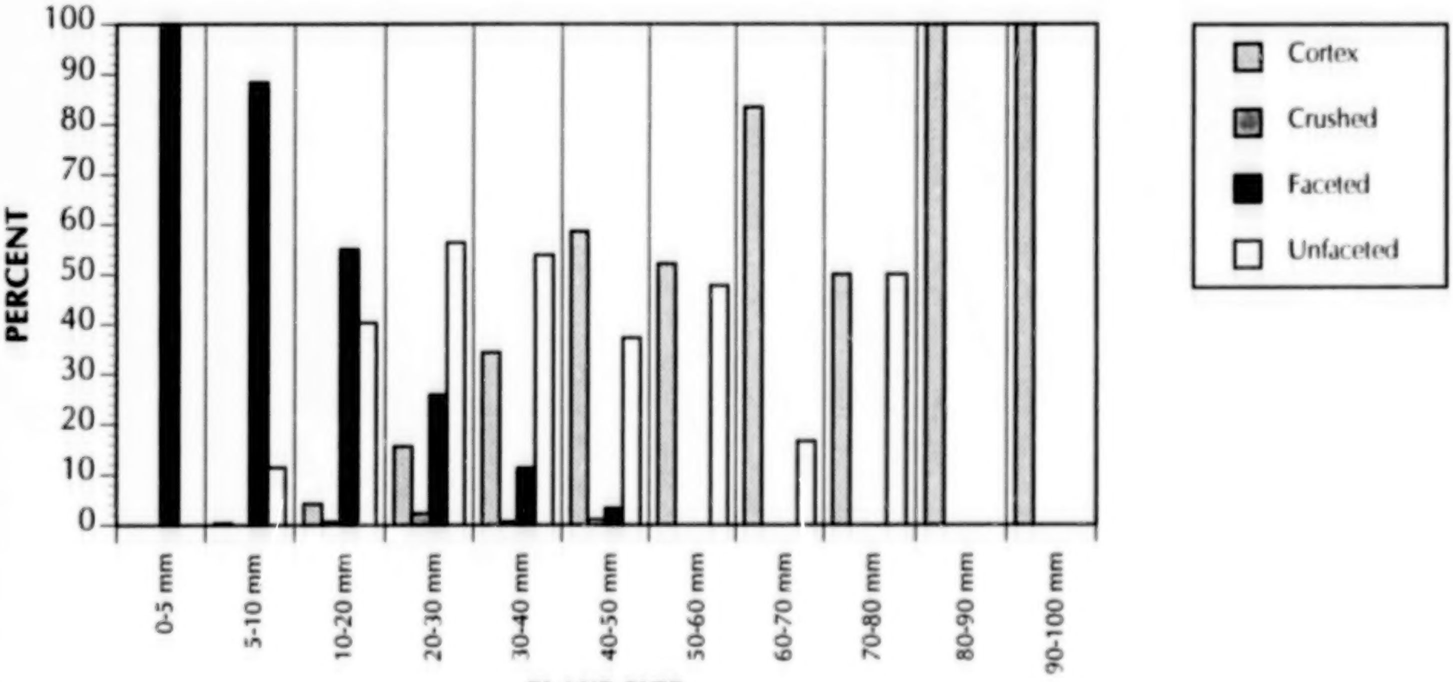

Figure 22. Percentage of platform morphology classes for each size class for the chert debitage.

would have been produced during the initial reduction of a nodule. As would be expected, based on their production during the initial stages of core reduction, the primary decortication flakes all exhibit cortex and measure more than 60 mm in maximum diameter. In contrast, the biface edge removal, biface thinning, late stage pressure, and the multiple secondary flakes are all interior flakes, and they all measure less than 50 mm. The late stage pressure flakes all measure less than 20 mm.

SUMMARY

Analysis of the debitage from the analytical sample shows a marked difference between the obsidian debitage and the chert debitage recovered from the site. The obsidian debitage is made up entirely of small interior flakes that reflect the later stages of bifacial thinning, and includes a number of late stage pressure thinning flakes. The obsidian debitage is the product of late stage bifacial tool manufacture and the trimming and reworking of broken and edge-damaged finished tools that were brought to the site.

The obsidian debitage is consistent with the few obsidian tool fragments recovered from the site, including the large obsidian flake blank (Figure 10m) that displays small thinning scars along its edge margins. The fact that obsidian as a raw material had to be imported into the area from a considerable distance undoubtedly made this material a valuable commodity that was worked and reworked during its use-life. Because obsidian was not available locally, the early stages of core reduction and blank production were most likely undertaken closer to the source, with only smaller more regularized items, such as blanks or finished tools, imported as far as the coast. Thus a pattern of discard resulted in which only debitage from the later stages of tool manufacture was produced at localities near the Pacific Coast, such as the Bravo Creek site.

In direct contrast to the obsidian debitage, the chert debitage reflects all stages of stone tool manufacture, from the initial reduction of locally available chert nodules through core and biface reduction to the production of finished tools. The numerous large thick cortex-covered chert flakes, that also exhibited cortex-covered and unfaceted striking platforms, and the large numbers of angular debris recovered from the site are all by-products of the earlier stages of core and flake blank reduction. The early stages of lithic reduction are also represented by the recovery of a number of rough cores and crudely flaked flake blanks at the site.

The rest of the chert flakes are smaller and thinner, many with faceted platforms, and very few exhibit cortex. A few of these smaller interior flakes were identified as biface thinning, biface edge removal, and late stage pressure thinning flakes. These flakes and a large number of the flakes classified as normal flakes were produced during the mid- to late stages of biface reduction. Although late stage biface reduction and tool finishing are also represented in the chert debitage, these small flakes do not dominate the assemblage like they do with the obsidian debitage. The chert debitage is more heavily represented by flakes produced during core reduction and the early to mid- stages of biface reduction and less so by flakes diagnostic of the later stages. This pattern is also seen in the large number of cores and early to mid-stage bifaces recovered from the site.

The debitage recovered from the Bravo Creek site not only provides evidence that supports the lithic reduction sequence represented by the flaked stone tools recovered, but it also more fully documents the roles that both obsidian and chert played in the function of this site as a lithic workshop. Analysis of both the flaked stone tools and the debitage indicate that the reduction of locally available chert nodules and the manufacture of this material into stage reduction bifaces and finished tools was the primary activity engaged in at the site, with the finishing and refurbishing of small obsidian bifacial tools also conducted as an ancillary activity.

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V. PREHISTORIC USE OF THE BRAVO CREEK SITE

The Bravo Creek site is located 7.5 km inland from the Pacific Coast at an elevation of 107 m in the foothills of the Klamath Mountains. This site, which contains cultural deposits with a maximum depth of 80 cm, occupies an area of less than 600 m^2 on a high terrace overlooking Bravo Creek. Excavations at this locality involved removal of 9.8 m^3 of the cultural deposit from 14 excavation units that covered a total area of 14 m^2. (Test Pit 5, which was completely sterile, is excluded from these figures.) Although constituting only a 2.3% sample of the site area, the excavations were concentrated, for the most part, in the center of the site where the densest cultural deposits were located. It is considered highly likely that the recovered artifact assemblage is representative of the cultural materials at the Bravo Creek site.

The assemblage from the Bravo Creek site consists of 19,514 items, of which 175 are tools and the remaining 19,339 are lithic debitage. The volume of excavation, frequency of recovered tools and debitage, and average density by volume for each excavation unit are listed in Table 8. Tool recovery ranged from 3.3 to 25/m^3, with an average of 13.73/m^3. Debitage recovery ranged from 951.25 to 3240/m^3, with an average of 1972.86/m^3. Considering the assemblage as a whole, the Bravo Creek site produced a density of 1986.53 items per cubic meter.

SITE FUNCTION

The artifact assemblage recovered from the Bravo Creek site contains a limited range of tool types, with bifaces, unifaces, cores, and hammerstones the most common artifacts classes represented (Table 9). Overall, the recovered cultural materials are dominated overwhelmingly by lithic debitage. Considering the clear emphasis on the manufacture of stone tools in evidence, the Bravo Creek site appears to have functioned primarily as a lithic workshop.

Although the reduction of lithic material into flaked stone tools was clearly the primary site activity, it seems reasonable to suggest that tasks related to subsistence were also carried out to some extent. As preservation of organic remains was virtually non-existent, no direct evidence of the fauna that may have been hunted or the flora that may have been gathered at this site is available. A review of the artifact inventory reveals few tools that clearly relate to activities other than lithic reduction. That some hunting

Table 8. Artifact density data for the excavated assemblage from the Bravo Creek site.

Unit	M^3	Tools	Tools/m^3	Debitage	Debitage/m^3	Total	M^3
1	0.5	5	10	798	1596	803	1606
2	0.8	20	25	1378	1722.5	1398	1747.5
3	0.8	16	20	2592	3240	2608	3260
4	1.0	15	15	2224	2224	2239	2239
6	0.8	12	15	1474	1842.5	1486	1857.5
7	0.8	4	5	761	951.25	765	956.25
8	0.6	2	3.3	846	1410	848	1413.3
9	0.6	7	11.7	915	1525	922	1536.7
10	0.8	13	31.7	1523	1903.75	1536	1920
11	0.8	12	15	1128	1410	1140	1425
12	0.3	2	6.7	368	1226.7	370	1233.3
13	0.8	10	12.5	2116	2645	2126	2657.5
14	0.7	12	17.1	2060	2942.9	2072	2960
15	0.5	4	8	1151	2302	1155	2310
TOTALS	9.8	134	13.73	19334	1972.86	19,468	1986.53

and butchering activities were conducted is suggested by the recovery of projectile points and an endscraper, and possibly by the finding of used flakes and flaked spalls as well. No artifacts indicative of plant processing and no artifacts associated with fishing are represented in the assemblage. Although Bravo Creek and the nearby North Fork of the Chetco River have significant runs of anadromous fish, the position of the site more than 100 meters above the creek severely limits access to riverine resources below.

LITHIC REDUCTION SEQUENCES

Lithic reduction is a subtractive process that results in either a finished product or a broken or aborted stage reduction implement, as well as the waste flakes (debitage) created during each flaking episode (Callahan 1979:33). A number of models designed to clarify the sequence or steps undertaken by prehistoric flintknappers in the production of flaked stone tools from unmodified pieces of raw material to finished tools have been presented (e.g., Muto 1971; Bradley 1975; Collins 1975; Callahan 1979; Frison and Bradley 1980). These models have invariably involved delineating the stages of reduction that a class of tools underwent during the manufacturing process.

Because finished tools often do not reveal much about the processes by which they were formed, it is the unfinished artifacts and flaking debris, discarded during the reduction process, that provide the most insight into the stages of manufacture represented at a particular locality. It has been pointed out by most lithic reduction

Table 9. Inventory of artifacts from the Bravo Creek site.

	LEVEL											
Artifact Class	S	1	2	3	4	5	6	7	8	9	10	Total
Flaked Stone Tools												
Projectile Points	1	2	2	1	-	3	1	-	-	-	-	9
Preforms	-	-	-	1	2	1	-	1	-	-	-	6
Bifaces	14	16	6	9	11	7	10	2	-	-	-	75
Unifaces	2	4	3	6	6	-	-	1	-	-	-	22
Endscraper	-	-	-	-	-	1	-	-	-	-	-	1
Used Flakes	-	-	1	2	1	1	2	2	-	-	-	9
Cores	1	2	6	2	2	2	-	-	-	-	-	15
Cobble Tools												
Hammerstones	7	2	-	3	-	-	-	-	-	-	-	12
Anvilstones	5	-	-	1	1	1	-	-	-	-	-	7
Flaked Cobbles	4	-	-	3	1	-	-	-	-	-	-	8
Battered Cobbles	-	1	-	-	-	-	-	-	-	-	-	1
Flaked Spalls	7	-	-	-	-	-	-	-	-	-	-	7
Debitage												
Obsidian	1	153	179	109	104	72	61	23	14	-	-	716
Chert	10	4872	3338	2173	2255	2306	2159	1088	407	7	-	18,615
Basalt	-	4	2	1	-	1	-	-	-	-	-	8
Miscellaneous												
Pipe Stem	-	1	-	-	-	-	-	-	-	-	-	1
Total Tools	41	28	19	28	24	16	13	6	-	-	-	175
Total Debitage	11	5029	3519	2283	2359	2379	2220	1111	421	7	-	19,339
Excavated Volume		1.4	1.4	1.4	1.3	1.3	1.1	0.9	0.8	0.1	0.1	9.8 m^3

studies that the reduction process can be viewed as a continuum, from the procurement of the raw material and its subsequent modification into the final formed tool.

However, the reduction process can be halted at any time either to allow for the use or curation of an implement or to discard a broken or unsatisfactory item due to failure in either the flaking technique or the material itself. The reduction process may also be discontinuous in time, with different stages of reduction undertaken at differing locations across the landscape, as the flintknapper moves through a daily or seasonal round, or as the material is traded between individuals.

Most stage reduction models begin with the acquisition of the raw material and the production of unmodified flake blanks during core reduction (Stage 1). The reduction process then usually shifts to the reduction of flake blanks, often using direct hard hammer percussion for the initial or preliminary thinning and shaping stage of reduction (Stage 2). The initial reduction of the flake blank often results in the production of a bifacial blank, although unifacial tools may also be produced from unmodified flake blanks. The reduction process then proceeds with the implementation of primary (Stage 3) and secondary thinning (Stage 4), including both percussion and pressure flaking, using both soft and hard percussors. These mid- to late-stage thinning techniques result in a progressively thinner and more refined bifacial blank as the reduction process continues. Late stage thinning often ends with the preform stage (Stage 5). The preform is commonly produced just prior to the final pressure thinning and shaping of a biface into a finished tool. The preform is similar in size and basic shape to the finished product, but in the case of projectile points lacks a haft element, such as notches, shoulders, or a stem. It is at the preform stage that the intended final product of the flintknapper becomes most apparent. Although the reduction process ends with the finished product, it should be noted that finished tools were often subjected to reworking and rejuvenation after use or breakage.

All stages of the reduction process are seldom recovered at a single locality. The early stages are often found near the source of the raw material, while the later stages are more likely to be recovered at various other locations utilized by the prehistoric inhabitants. Thus the lithic material at a site may represent only a part of the reduction sequence, with other sites containing other stages of the reduction process. In this respect, the Bravo Creek site stands out, as the lithic material recovered includes artifacts that encompass the entire lithic reduction process, from the initial splitting of the local chert nodules and rough core reduction through all stages of biface reduction (Figure 23). The reduction process was structured to accommodate both thin and thick flake blanks, with flaking techniques depending on the shape and thickness of the flake blank. Large numbers of early and mid-stage bifaces, especially fragments, were discarded at the site, providing physical evidence of each stage of reduction.

The reduction process at the Bravo Creek site was designed to produce two basic preform types. The first type is a parallel-sided straight-based preform that is represented by only a single example (Figure 13j). This preform has the same base width as the large corner-notched base fragment, indicating that this point type could have been produced from a preform of this type by just flaking notches into the sides of the piece (Figure 24b). This preform could also be transformed into a small corner-notched point by applying basal notches to create a small stem (Figure 24c), as seen on one of the narrow-necked points that has the same maximum width measurements as the base measurement of the preform.

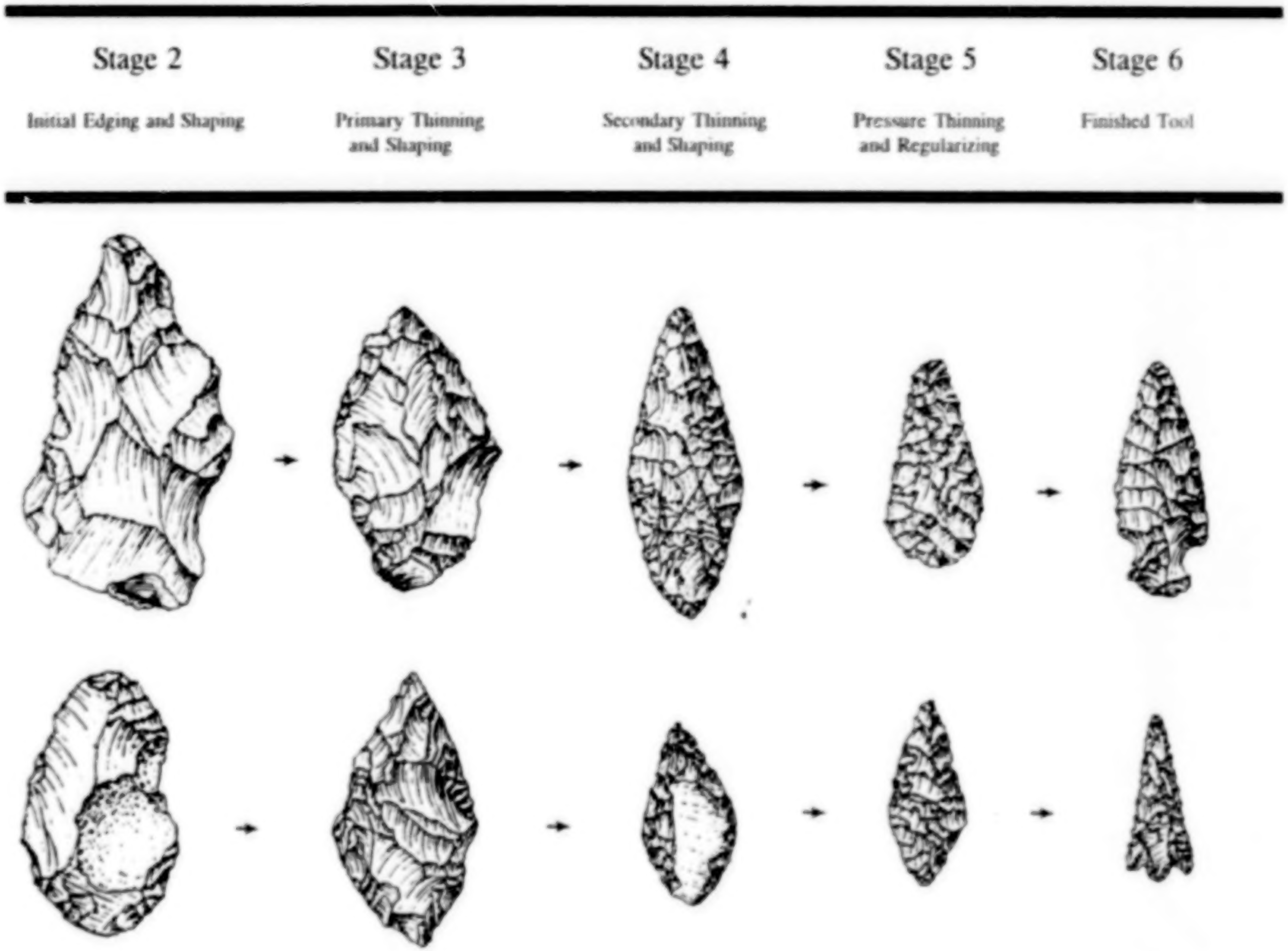
Stage 2
Initial Edging and Shaping
Stage 3
Primary Thinning and Shaping
Stage 4
Secondary Thinning and Shaping
Stage 5
Pressure Thinning and Regularizing
Stage 6
Finished Tool

Figure 23. The biface reduction sequence represented at the Bravo Creek site.

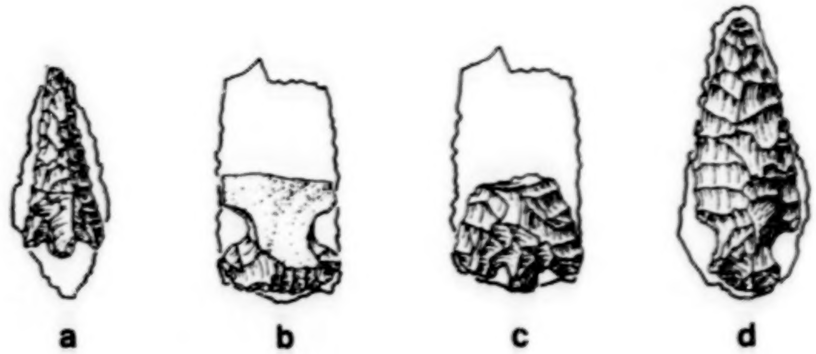

Figure 24. Illustration showing projectile points superimposed over preforms, depicting the various notching techniques used: a, TP6-7/2-1 (preform) and TP7-5/1-1 (projectile point); b, TP6-7/2-1 (preform) and TP3-5/1-1 (projectile point); c, TP11-3/1-1 (preform) and TP3-1/1-1 (projectile point); d, TP2-5/2-2 (preform) and TP3-6/2-1 (projectile point).

The other preforms, with rounded or pointed convex bases, are the most prevalent type recovered from the site. These small leaf-shaped specimens are commonly classified as projectile points, and some specimens of this type may have functioned in that capacity. These small bipointed bifaces, however, could have been preforms for the small corner-notched points that were made by notching into the corners of the base leaving a pointed contracting stem (Figure 24a). The larger bifaces with rounded convex bases could have been preforms for the large corner-notched round-based points. The complete large corner-notched point recovered is the same size as the large preforms, and if corner notches were applied to the edges of the base on these preforms a corner-notched point with an expanding rounded stem would have been produced (Figure 24d).

Biface reduction at the Bravo Creek site was for the most part structured towards the production of bi-pointed and rounded convex base preforms, which were then flaked into either large or small corner-notched points depending on the size of the preform produced. Most of the bifacial material that was left at the site is either broken or has an unfinished appearance, indicating that the better quality preforms and projectile points were taken from this locality to be used and discarded elsewhere. In fact, lithic material at any stage in the reduction process could have been removed from the site to be further reduced elsewhere. Bifacial blanks, preforms, and projectile points similar to those recovered from the Bravo Creek site are undoubtedly present at many other sites in the region.

COMPARISON WITH NEARBY FOOTHILL SITES

Aside from the Bravo Creek site, few prehistoric sites situated away from the coastline in Curry County have so far been subjected to archaeological investigations. Of the localities that have been tested, the Curtday site (35CU149), Winchuck site (35CU176), Miller's Ridge site (35CU164), and Candy site (35CU167) have been the most thoroughly sampled, analyzed, and reported. Although direct comparisons are hampered somewhat by differences in artifact classification systems and reporting methods, the artifact assemblages recovered from these sites are summarized in Table 10.

The Curtday site, located 22 km upstream from the mouth of Pistol River, was identified as a "core/biface reduction work station" where hunting and gathering were conducted as secondary activities (Nilsson and Maniery 1987:6-17). The site is located on a series of benches on the side of a ridge overlooking the Pistol River drainage at an elevation of approximately 275 m. The artifact assemblage from this site, which covers an area of 10,362 m^2, was dominated by lithic debitage, cores, and bifaces, but a number of projectile points, retouched tools (mostly scrapers and used flakes), and groundstone tools were also recovered. The groundstone tools included one whole and several fragmentary bowls and three metate surfaces. Radiocarbon dates of 3220 ± 190 B.P. and 1990 ± 85 B.P. were reported from this site, but the charcoal samples on which they are based are believed to relate to natural burning instead of cultural activities (Nilsson and Maniery 1987:5-87-90). Projectile points found at the Curtday site include large corner-notched (n=7), large contracting stem (n=4), medium side-notched (n=5), and large leaf-shaped (n=2). As a group, these points are interpreted to reflect primary occupation between 4000 and 2000 years B.P., with sporadic use continuing after that time. Interestingly, the Gunther Series and other small narrow-necked points characteristic of late prehistoric occupation in Southwest Oregon and Northwest California were not found at the Curtday site.

The Winchuck site (35CU176), located 12 km upstream from the Pacific Coast at the confluence of the Winchuck River with Bear Creek, has been described as a "residential base camp" (Flenniken, Ozbun, and Markos 1992a:ii). The site is situated on the west bank of the Winchuck River at an elevation of approximately 60 m. A Clovis point was recovered during test excavations (Hemphill 1990), but subsequent excavations did not identify a Clovis component at this site (Flenniken, Ozbun, and Markos 1992a:81).The cultural deposit at this site, which covered an area of 10,000 m^2, consisted of a single stratum containing cultural materials to a depth of 100 cm. The recovered artifact assemblage included 15,475 lithic items, of which 8417 items (54%) were included in the "analyzed sample." The artifact assemblage is dominated by bifaces and unifaces, but also includes relatively high numbers of projectile points and preforms, cores, flake tools, and flaked cobbles. A radiocarbon date of 1120 ± 90 B.P. (WSU-3960) obtained from a "burnt stick" recovered during the test excavations (Hemphill 1990) is now thought to have been derived from naturally-burned roots rather than as a

Table 10. Comparative data from five foothill sites.

Artifact Class	Bravo Creek	Curtday Site	Winchuck Site	Miller's Ridge	Candy Site
Flaked Stone Tools					
Projectile Points:					
Gunther series	6	-	5	-	-
Medium Side-notched	-	5	-	-	-
Large Corner-notched	3	7	3	-	-
Large Contracting Stem	-	4	8	-	-
Leaf-shaped	-	2	2	16	-
Unclassifiable fragments	1	26	1	-	-
Bifacial Knives	-	3	-	-	-
Preforms	6	-	4	4	-
Bifaces	75	10[illegible]	92	5	11
Unifaces	22	5	31	9	-
Flake Tools	10	66	12	1	-
Cores	15	28	17	-	5
Cobble Tools					
Hammerstones	12	1	1	1	-
Anvilstones	8	-	3	-	-
Flaked Cobbles/Spalls	15	-	18	-	-
Battered Cobbles	1	1	1	-	-
Groundstone Tools					
Mortars	-	4	-	-	-
Mortar/Metate	-	1	-	-	-
Mano	-	1	-	-	-
Unidentifiable Groundstone	-	2	1	-	-
Debitage					
Chert[1]	19,328	21,400	7373[2]	6725[3]	2892
Obsidian	716	16	564[2]	62[3]	20
Other Materials[4]	8	49	480	1[3]	-
Manuports		16	-	-	-
Miscellaneous					
Pipe Fragments	1	-	5	-	-
Polished Steatite Pebble		1	-	-	-
Total Assemblage	19,514	21,759	15,475	12,255	2969
Volume Excavated	9.8 m^3	14.6 m^3	34.1 m^3	24.5 m^3	11.3 m^3
Artifact Density	1986.5/m^3	1488/m^3	454/m^3	500/m^3	263/m^3

[1] As used here chert encompasses cryptocrystalline silicates (Nilsson and Maniery 1987:5-2) as well as microcrystalline varieties of quartz including chalcedony (Flenniken, Ozbun, and Markos 1992a:51; 1992b:70).

[2] These figures are *approximate* counts based on the percentages of raw material within "the analyzed sample" (n=8417) [which] "represents 54% of the recovered site assemblage" [n=15,475] (Flenniken, Ozbun, and Markos 1992a:50-51).

[3] These figures are the frequencies provided in the project report for "the analyzed portion of the assemblage (n=6904) [which] is 56% of the recovered lithic artifacts" [n=12,255] (Flenniken, Osbun, and Markos 1992b:69).

[4] Other materials include "rocks of various geological origin and include vein quartz, basalt, quartzite, steatite, sandstone, siltstone, and undifferentiated igneous, metamorphic, and sedimentary rocks" (Flenniken, Ozbun, and Markos 1992a:51-52).

result of cultural activity (Flenniken, Ozbun, and Markos 1992a:40-41). Two other radiocarbon dates on charcoal from a hearth considered "potentially late prehistoric in origin" yielded dates of 100.9 ± 0.8% modern (Beta-47956) and 20 ± 60 B.P. (Beta-47957). The 19 projectile points recovered included two leaf-shaped points, three large corner-notched and eight large contracting stem specimens, and five Gunther Series points. Collectively, these point types potentially span the period from 8500 B.P. to the early historic period (Flenniken, Ozbun, and Markos 1992a:83-84).

The Miller's Ridge Lithic Scatter (35CU164), located approximately 15 km inland from the Pacific Coast near the crest of the ridge that separates the North Fork of the Pistol River and the Pistol River, has been described as "a short-term hunting base camp" (Flenniken, Ozbun, and Markos 1992b:83). The site is situated on a small flat near the ridgecrest at an elevation of approximately 830 m. The cultural deposit consisted of a single stratum containing cultural materials to a depth of 90 cm. The recovered artifact assemblage includes 12,255 lithic items, including 24 projectile points, four preforms, five bifaces, nine unifaces, one flake tool, and one hammerstone. The remaining items are presumably debitage. No radiocarbon dates were obtained. The 24 projectile points include 16 classifiable specimens, all of which are of the "leaf-shaped" or lanceolate type. This point type is of limited utility as a chronological indicator, as it is known to have been used from 8500 to 2250 B.P. (Flenniken, Ozbun, and Markos 1992b:81-85).

The Candy site (35CU167) is located approximately 3 km north of the Miller's Ridge Lithic Scatter (35CU164). The site is situated on the edge of a small saddle at the northern end of Miller's Ridge at an elevation of approximately 865 m (Flenniken, Ozbun, and Markos 1992b:45-61). The cultural deposits consisted of a single stratum containing cultural materials to a depth of 70 cm. The recovered artifact assemblage includes 2969 lithic items, including 11 bifaces and five cores. The remaining items are presumably debitage. No radiocarbon dates were obtained, and no temporally-diagnostic artifacts were found.

In addition to their foothill settings, the Bravo Creek, Curtday, Winchuck, and Miller's Ridge sites obviously have much in common, most notably in the fact that core/biface reduction is the primary activity. Of these localities, the Curtday site stands out for containing a number of groundstone tools (n=8). Groundstone tools may also be represented at the Winchuck site (Flenniken, Ozbun, and Markos 1992a:66,75,78). The Curtday site also produced a higher number of flake tools, especially scrapers and used flakes, than the other four interior sites. All four foothill sites produced large amounts of lithic debitage, with Bravo Creek having the highest density at 1986/m^3. This high density is due in part, of course, to the concentration of activity within the area of the small bench on which the Bravo Creek site is situated. Debitage from all sites consists overwhelmingly of various types of chert, which as defined here encompasses cryptocrystalline silicates (Nilsson and Maniery 1987:5-2) as well as microcrystalline varieties of quartz including chalcedony (Flenniken, Ozbun, and Markos 1992a:51;

1992b:70). These lithic materials are common in the region and occur as bedrock outcrops, ridge gravels, and river gravels.

The Bravo Creek site also produced the largest number of obsidian debitage (n=716), or at least the highest density of obsidian debitage, of the four foothill sites. It is possible that the frequency of obsidian debitage at the Winchuck site was higher, as the 564 obsidian specimens represent 6.7% of the analyzed sample (n=8417), which was 54% of the total assemblage (n=15,475) (Flenniken, Ozbun, and Markos 1982a:50-51). Obsidian sourcing analysis has been carried out on samples of obsidian specimens from all five of the above-mentioned interior sites by Richard E. Hughes (1986, 1991, 1992, 1993). As summarized in Table 11, of the total of 162 specimens that have been analyzed, the great majority (n=142 or 87.7%) were sourced to the Grasshopper Flat/Lost Iron Well/Red Switchback chemical group of the Medicine Lake Highland volcanic field in northeast California.

The ages of the occupations represented at these foothill sites obviously are not well established. Radiocarbon assays are available from the Curtday, Winchuck, and Bravo Creek sites, but in all cases questions have arisen as to whether the dates obtained relate to prehistoric occupation or to natural fires (Nilsson and Maniery 1987:5-87-5-90). In fact, two of the three dates from the Winchuck site are modern in age (Flenniken, Ozbun, and Markos 1992a:40-44).

Table 11. Obsidian sourcing data from five foothills sites.

	Obsidian Source				
Site	GF/LIW/RS	SL/SM	SMtn	EML	OC/IC
Curtday Site	4	-	-	-	1
Winchuck Site	46	12	4	1	-
Miller's Ridge	68	-	-	-	-
Candy Site	12	1	1	-	-
Bravo Creek	12	-	-	-	-
TOTALS	142	13	5	1	1
PERCENT	87.7	8.0	3.1	0.6	0.6

GF/LIW/RS = Grasshopper Flat/Lost Iron Well/Red Switchback
EML = East Medicine Lake
SL/SM = Silver Lake/Sycan Marsh
SMtn = Spodue Mountain
OC/IC = Obsidian Cliffs/Inman Creek

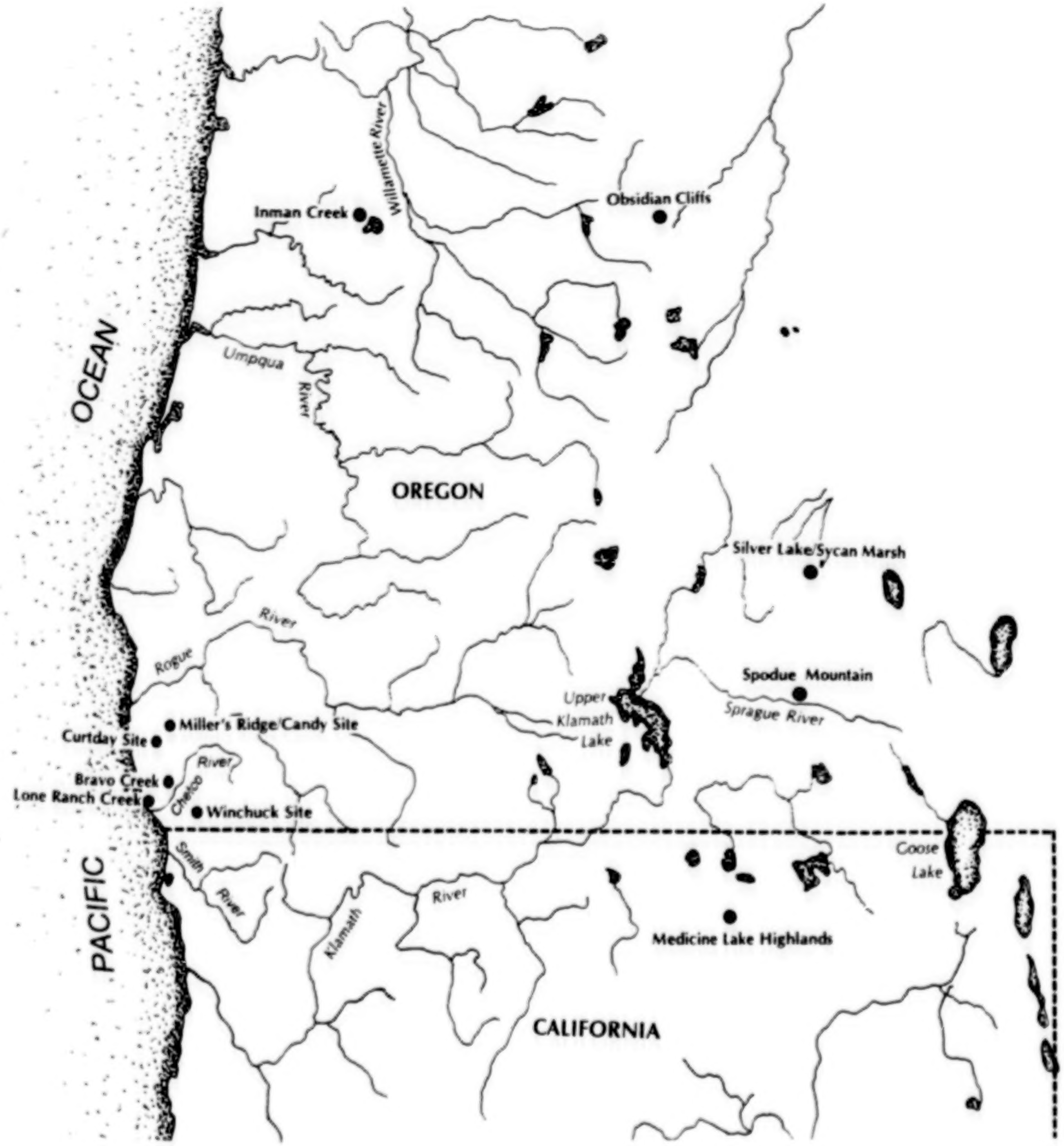

Figure 25. Location of obsidian sources identified at sites in the Klamath Mountain foothills.

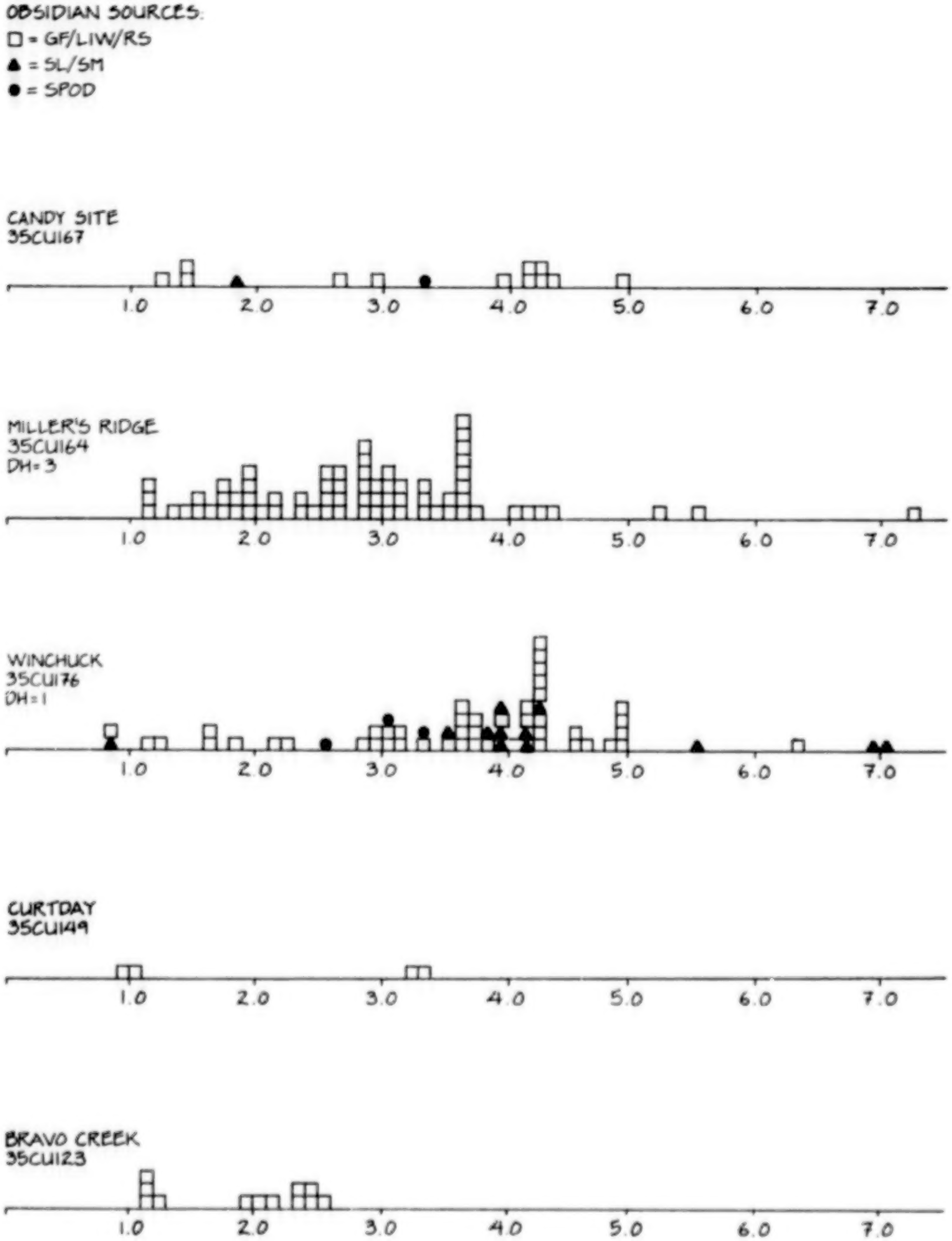

Figure 26. Hydration values in microns for obsidian specimens from sites in the Klamath Mountain foothills.

In the absence of clearly reliable radiocarbon dates, typological cross-dating of projectile points is generally used to estimate the timespans of prehistoric site occupations. Classification of the projectile points from four of the five foothill sites (no projectile points were recovered from the Candy site) is summarized in Table 10. Based on previous archaeological research in Southwest Oregon and Northwest California (as well as elsewhere in western North America), the projectile point sequence is generally thought to have shifted in emphasis through a range of shapes beginning with lanceolate or leaf-shaped points used with thrusting spears, followed by broad-necked points associated with the atlatl and dart, and ending with a predominance of small narrow-necked points used with the bow and arrow (e.g., Pettigrew and Lebow 1987).

In their interpretation of the projectile points from the Curtday site, Nilsson and Maniery (1987:5-51-5-63) suggested time ranges of 6000 to 2000 B.P. for leaf-shaped points, 5000-1000 B.P. for large corner-notched and contracting stem broad-necked points, and 1100 B.P. to historic times for side-notched points. Based on these suggested time ranges, it would appear that use of the Miller's Ridge site was limited to an early occupation. In contrast, the Curtday and Winchuck sites were apparently occupied from relatively early into late prehistoric times. Of the four sites, Bravo Creek apparently had the shortest occupation span, with use also continuing into late prehistoric times.

However, the utility of projectile point cross-dating for estimating site occupation spans has recently been questioned, both generally (e.g. Flenniken and Raymond 1986; Flenniken and Wilke 1989) and specifically in regard to the Winchuck and Miller's Ridge sites (Flenniken, Ozbun, and Markos 1992a:82-84; 1992b:83-85). In brief, projectile point shape is considered unreliable as a basis for inferring chronology because "shape changes as a result of the dynamic process of use, resharpening, and rejuvenation" (Flenniken, Ozbun, and Markos 1992a:84).

In addition to projectile point cross-dating, obsidian hydration values can be used to obtain a general idea of the age of these foothill sites. Samples from all five sites have been analyzed by Thomas M. Origer (1986, 1991, 1992, 1993). Previous obsidian studies in the Elk Creek locality of southwestern Oregon have indicated "no significant differences in hydration rate exist" for obsidian from the Grasshopper Flat/Lost Iron Well/Red Switchback, Spodue Mountain, and Silver Lake/Sycan Marsh sources (Pettigrew and Lebow 1987:9.11). Obsidian from these sources account for 160 of the 162 specimens from the five interior sites whose sources have been established (Figure 25). Four specimens (one from the Winchuck site and three from Miller's Ridge) did not have discernible hydration rims, reducing the number of specimens with hydration values from these sources to 156.

As summarized in Figure 26, the hydration data suggest relatively long occupation spans for the Winchuck, Miller's Ridge, and Candy sites, a somewhat shorter occupation span for the Curtday site, and the shortest occupation span of all for the Bravo Creek site. Interestingly, the obsidian hydration data showing a long occupation span at the

Miller's Ridge site are at odds with the age estimate from projectile point cross-dating which, based on the exclusive presence of leaf-shaped points, suggests that use of the site was limited to an early occupation. This situation supports the idea that leaf-shaped points "are indicative of a very successful, long-lasting tradition of thrusting spear use, possibly in conjunction with communal hunting, rather than time periods" (Flenniken, Ozbun, and Markos 1992b:85). The obsidian hydration data also suggest the possibility that two temporally separate occupations may be represented at the Curtday and Bravo Creek sites, although this interpretation must be considered with caution because of the small size of the samples for which hydration and sourcing information are available.

As previously discussed in Chapter 2, an obsidian hydration rate for converting hydration measurements into radiocarbon years has not yet been calculated for the southern Oregon coastal region. In the absence of a local hydration rate, the rate of 4.1 microns^2 per 1000 radiocarbon years calculated for the Elk Creek locality in the upper Rogue River Basin (Connolly 1991:46-47) was applied to the hydration values from the Bravo Creek site to obtain an idea of the age of the occupation there. Assuming that the obsidian hydration rate from the Elk Creek locality provides reasonable age estimates, it becomes apparent that hydration values in the 4.0-5.0 micron range, which are well represented among the hydration measurements, may indicate occupation of the Winchuck, Miller's Ridge, and Candy sites as early as circa 4000-6000 B.P. The seven hydration values larger than 5.0 microns from the Winchuck and Miller's Ridge sites may indicate occupation even earlier.

Application of the hydration rate from the Elk Creek locality, then, results in age estimates that are generally consistent with those derived from projectile point cross-dating. It should be kept in mind, however, that these age estimates must be considered with caution because a local hydration rate has not yet been established. Obviously, the reliability of projectile point cross-dating for estimating the age of site occupations is not an issue that can be resolved with the data currently available from sites in the Klamath Mountain foothills. Indeed, these sites are poorly suited for detailed analysis because of the unstratified nature of the cultural deposits, the extensive disturbance and mixing of the cultural deposits by rodents and roots, and the lack of radiocarbon dates clearly associated with human occupation.

VI. THE BRAVO CREEK SITE IN REGIONAL PERSPECTIVE

Located in the Klamath Mountain foothills 7.5 km inland from the Pacific Ocean, the Bravo Creek site is interpreted to represent a lithic workshop where core and biface reduction were the primary activities. Subsistence-related tasks such as hunting and gathering were presumably also carried out. Fishing in Bravo Creek would have been highly productive in conjunction with seasonal runs of anadromous fish up the North Fork Chetco River. Overall, however, little or no evidence was found of subsistence-related activities. The primary focus of the site's inhabitants was clearly on the manufacture of flaked stone tools.

The chronology of the Bravo Creek site occupation is not well established. Obsidian hydration values suggest that two cultural components may be represented. A radiocarbon date of 2710 ± 60 B.P. was obtained, but it is possible that it relates to natural fires rather than to human activity. Obsidian hydration age estimates suggest that occupation occurred somewhat later, between circa 1650 and 350 B.P. The small narrow-necked projectile points most common at this site are assignable to the Gunther Series, which has a known time range from late prehistoric times into the historic era.

RELATION TO THE PREHISTORIC PATTERN

Until recently, the prehistory of the southern Oregon-northern California coastal region was considered to have relatively little time depth. Almost all of the sites investigated contained shell midden deposits that seemed to reflect the presence of native groups closely adapted to marine resources--fish, mollusks, and sea mammals--found along the coastal margin. This coastal adaptation was viewed as the economic basis for a cultural florescence that, while related in general to the Northwest Coast culture area, was a local development centered in Northwest California (Elsasser 1978:52). The appearance of this coastal adaptation is thought to have coincided with the arrival in the region of the Yurok and Wiyot, and the Athapaskan-speakers somewhat later, approximately 1000 years ago (Elsasser 1978:50).

In terms of archaeological expressions, the emergence of complex societies based on a marine economy has been correlated with the Gunther Pattern, named for the Gunther Island site on Humboldt Bay (Fredrickson 1984:484-491). Noteworthy artifacts characteristic of the Gunther Pattern include small narrow-necked projectile points, especially those of the Gunther Series, small grooved and notched net weights, shallow steatite vessels (grease catchers), large obsidian ceremonial blades, zooform clubs ("slave killers"), and baked clay figurines. The distribution of the Gunther Pattern has recently been extended northward to encompass late prehistoric manifestations in the portion of Southwest Oregon occupied by Athapaskan-speaking peoples at the time of historic contact (Connolly 1986, 1988).

For many years the only known exception to the Gunther Pattern was the early component at Point St. George on the northern California coast, which was characterized primarily by chipped stone tools and debitage. Groundstone tools indicative of acorn processing, bone tools, and fishing equipment were all absent, and the scanty evidence of food remains reflected "little interest in the abundant marine fauna at the Point" (Gould 1966:87). A radiocarbon date of 2260 ± 210 B.P. was later obtained from charcoal associated with the Point St. George I occupation (Gould 1972). Subsequent research along the southern Oregon coast has documented a number of similar manifestations, and radiocarbon dates from these "lithic sites" has gradually pushed back the time depth of prehistoric occupation in this region to circa 5,000 B.P. (Table 12).

Because projectile points found at lithic sites seem to indicate earlier occupation than is apparent in most shell middens, it has been suggested that lithic sites may reflect occupation by "pre-marine" or "pre-littoral" cultures antedating the emergence of marine-oriented cultures in the region (Ross 1990:554-555; Lyman 1991:79-80; 83-84). A careful review of the archaeological literature, however, indicates that many of the "early" point types found at lithic sites are also represented in marine shell middens in this region, including Lone Ranch Creek (Berreman 1944), Pistol River (Heflin 1966), and Port Orford Heads (Ross 1977; Draper 1988). This situation suggests, then, that a marine adaptation, resulting in the accumulation of shell midden deposits, is considerably older than generally recognized, and is probably as old as most lithic site occupations.

For present purposes, prehistoric sites in the southern Oregon-northern California coastal region that have been investigated to date can be assigned to two broad periods of occupation (Table 12). Because relatively few radiocarbon dates are available, chronological estimates rely heavily on projectile point cross-dating. Early period sites are characterized by leaf-shaped points, broad-necked points with contracting or expanding stems, and large side-notched points. Late Period sites are characterized by small narrow-necked, concave base, and small side-notched points (Pullen 1982; cf. Minor and Toepel 1983).

Radiocarbon dates currently available from prehistoric sites in the southern Oregon-northern California coastal region indicate considerable overlap in the age of lithic sites and shell middens (Table 12). As well, none of the radiocarbon dates so far available are appreciably older than the earliest known shell midden deposit on the Southern Northwest Coast, found in the Tahkenitch II component at Takhkenitch Lake on the central Oregon coast radiocarbon dated at 5100 ± 70 B.P. (Minor and Toepel 1986). Instead of representing an evolutionary sequence, then, it seems more likely that lithic sites and shell middens represent different aspects of the settlement-subsistence

Table 12. Summary of chronological data for excavated prehistoric sites in the Southern Oregon-Northern California coastal region (sites are listed north to south).

Site	Period		Radiocarbon Dates	Laboratory Numbers	References
	Late	Early			
Strain	X		none*		Newman 1959
Blacklock Point		X	2750 ± 55**	DIC-1911	Ross 1984
Cape Blanco Lithic Site		X	5140 ± 90** 5280 ± 80** 5390 ± 100**	Beta-46280 Beta-46281 Beta-46279	Minor and Greenspan 1991
Port Orford Heads	X	X	none*		Ross 1977; Draper 1988
Blundon	X	X	630 ± 55* 2050 ± 80**	DIC-1777 I-11,334	Minor, Beckham & Greenspan 1980
35CU62		X	3000 ± 90*	GaK-1317	Cressman 1977
Pistol River	X	X	none*		Heflin 1966
Curtday	X		1990 ± 85*** 3220 ± 190***	WSU-3545 WSU-3459	Nilsson and Maniery 1987
Indian Sands	X	X	1140 ± 80* 1630 ± 70* 2380 ± 90** 80 ± 90** 1310 ± 60**	Beta-44476 Beta-44477 Beta-44478 Beta-44479 Beta-44480	Minor and Greenspan 1991
Bravo Creek	X	X	2710 ± 60***	Beta-61923	(This volume)
Lone Ranch	X	X	none*		Berreman 1944
Winchuck Site	X	X	1120 ± 90*** 100.9 ± 0.8%$^{\text{modern}}$ 20 ± 60***	WSU-3960 Beta-47956 Beta-47957	Hemphill 1990 Flenniken et al. 1992a
Point St. George	X	X	2260 ± 210**	I-4006	Gould 1966, 1972
Stone Lagoon	X	X	1860 ± 120* 1490 ± 100* 215 ± 100*	UCR-884 UCR-885 UCR-883	Milburn et al. 1979
Patrick's Point		X	640 ± 90* 545 ± 115*	GX-0181 GX-0182	Elsasser and Heizer 1966
Tsurai		X	none*		Heizer and Mills 1952; Elsasser 1965; Elsasser and Heizer 1966
Gunther Island		X	1050 ± 200*	M-938	Loud 1918; Crane and Griffin 1961

* = shell midden ** = lithic site/component *** = inland lithic workshop

system of the same prehistoric populations (Minor and Toepel 1983:232; Minor and Greenspan 1991:60-62).

In view of their proximity to the coastal margin, it seems reasonable to suggest that the Bravo Creek site and the other four localities so far investigated in the Klamath Mountain foothills represent an aspect of the settlement-subsistence systems of prehistoric peoples who lived along the southern Oregon coast (Nilsson and Maniery 1987:6-9; Flenniken, Ozbun, and Markos 1992a:96; 1992b:106). Judging from the obsidian hydration measurements obtained from the Winchuck and Miller's Ridge sites, this foothills aspect appears to have considerable antiquity, perhaps on the order of 4000-6000 years. This inference is supported by similarities in material culture, especially projectile points, found at sites in the foothills and coastal environments. For example, the large leaf-shaped points recovered at the Miller's Ridge site (see Flenniken, Ozbun, and Markos 1992b:76-77, Figures 25 and 26) have close counterparts in the artifact collection from the Indian Sands site (35CU34) on the coast (Berreman 1935:54-55, Plate I).

The foothills aspect of the settlement-subsistence system presumably reflects the practice of seasonal movements from the coastal margin into the adjacent foothills and uplands of the Klamath Mountains. Seasonal movements to exploit resources as they become available in different microenvironments were, of course, a highly characteristic practice among hunter-gatherers, and especially among the prehistoric peoples of California. In this respect it should be remembered that the environment of the Klamath Mountains is more similar to that of California than it is to the rest of Oregon. In particular, the herb and shrub plant communities, grasslands, and stands of oak found in the Klamath Mountain foothills contrast markedly with the forest-dominated landscape of the Coast Range to the north. This situation may account for the near-absence of evidence of use of the Coast Range environment by prehistoric peoples who lived along the central and northern Oregon Coast.

The results of archaeological surveys suggest that early-style projectile points are relatively common in the Klamath Mountain foothills (Reg Pullen, personal communication, 1992). This observation is supported by a study of artifacts found by relic collectors in the region (Pullen 1982). This situation has led to the suggestion that earlier prehistoric peoples relied more heavily on upland resources, especially those found along the upper reaches of coastal rivers, than did later peoples (Pullen 1982:96). In this respect it should be noted that during earlier times, for example during the Altithermal, a time of abnormally warm/dry climate that ended circa 3,000 B.P., the environment of the Klamath Mountain foothills would have been even more like that of California. Unfortunately, this idea that earlier peoples living along the southern Oregon coast made greater use of interior environments than later peoples will be difficult to assess, as most early coastal sites appear to have been inundated as a result of the postglacial sea level rise. At the same time, however, it is important to keep in mind that earlier peoples may have developed adaptations to the environment markedly different from those practiced by the ethnographic inhabitants.

RELATION TO THE ETHNOGRAPHIC PATTERN

Relatively little information is available about the ethnographic lifeways of the Athapaskan-speaking peoples who occupied Curry County at the time of historic contact. The Chetco inhabited the southern portion, while a number of bands that have come to be known collectively as the Tututni occupied the northern portion of the county (Berreman 1937:30-33). It is likely, however, that the settlement-subsistence practices of these peoples were similar to those of the better known Tolowa, their Athapaskan-speaking neighbors to the south.

In writing about Tolowa ethnogeography, Drucker (1937:226) noted that "the important towns were at the mouth of Smith river and southward along the coast, with a series of minor settlements or suburbs upriver, and only camp sites in the mountains." Drucker (1937:269) lists the names of three Chetco towns on the coast, specifically on the Winchuck and Chetco rivers, and three towns farther upstream around the mouth of the North Fork Chetco River, but he adds that "I am not at all sure that the last three places were real towns. They may have been fishing camps or something of the sort."

Salmon and acorns were of "basic importance" in Tolowa subsistence, with marine products such as smelt and mollusks next in significance. "The essentially coastal distribution of the population was probably at once a cause and a result of the importance of these latter foods" (Drucker 1937:231). Tolowa subsistence practices were summarized as follows:

> The food quest began in the early summer, when the people assembled along the river for the spring salmon run. Roots and berries began to ripen, and might be gathered. From the river they went to the beach to gather shellfish and smelt, and to hunt sea lions. These were cured for storage. When the fall salmon entered the river, in late summer, the people camped at the communal weir at munsontun, or at individually owned places, to catch and dry the winter's supply. Later, they moved up into the camp sites in the mountains, where the acorn crop was harvested and the men hunted deer. Winter, when the rains and cold weather set in, found the people back in the towns (Drucker 1937:232).

Drucker also noted that "the distribution of places of economic importance, namely, the fishing, hunting, and gathering tracts, make clear that each major town was an almost completely independent economic unit, surrounded by a continuous area from which subsistence could be obtained" (1937:226).

A detailed description of Tolowa settlement-subsistence practices, based on testimony provided by the residents of the historic village at Point St. George, has been recorded by Gould (1966:88-92). In analyzing Tolowa subsistence practices, Gould identified six "major procurement systems" which involved the acquisition of (1) large sea mammals, (2) marine shellfish, (3) acorns, (4) anadromous fish, (5) waterfowl, and

(6) surf fish, especially smelt. With the exception of acorns, these resources were concentrated along the coast.

> Only Procurement System No. 3, Acorns, required any wholesale movement of people away from the coast, and this was only for a few weeks during late fall. As mentioned earlier, productive oak flats were situated only a short distance from the coast, generally between 5 and 15 miles inland, so traveling distances were never great even between the most widely separated staple resources. In consequence, the Tolowa followed a seasonally regular, but narrowly-circumscribed pattern of movement between harvesting areas. In late summer, usually August, families moved from the large coastal villages onto the beaches to camp for several weeks while the smelt were running. Then they moved inland to various oak flats where they could collect acorns and, at the same time, fish during the fall salmon run. At the end of the acorn harvest these families would make their way individually back to the coastal villages where they remained for the remaining 9-10 months of the year (Gould 1975:163).

Aside from the "major procurement systems," one of the "minor procurement systems" among the Tolowa involved hunting of deer and elk in the interior. In regard to the relative importance of this activity, Gould writes:

> However, deer and elk are solitary game animals and cannot be hunted *en masse*. Stalking and pit-snares were used by individual Tolowa hunters to good effect, but total amounts of meat taken in this way cannot have been great compared to even the least productive of the staple food procurement systems (1975:159-160).

Drucker adds that because of the difficulty of stalking large game animals in the forested interior, "informants maintain that near-by hills were kept clear of brush by annual burning; this also improved the grass, so that deer frequented such clearings and could be shot easily (1937:233).

From the foregoing review it is apparent that the information available about ethnographic settlement-subsistence practices provides little context for interpreting the Bravo Creek site and other prehistoric sites so far investigated in the Klamath Mountain foothills. The principal activity undertaken by ethnographic peoples away from the coast, acorn gathering, would only be reflected if some processing of acorns, involving the use of groundstone tools, occurred in the field. If the acorns were simply gathered and transported directly back to the coastal villages, little evidence of this activity would be left in the archaeological record. The ethnographic record is somewhat vague on this point. It is noteworthy, however, that in describing the traditional acorn-gathering area of the Tolowa from Point St. George, Gould observes that "although signs of occupation in this area are scarce, the large groves still remain there today" (Gould 1966:89).

The only locality that would seem to clearly fit the ethnographic land-use pattern is the Curtday site which, with its complement of groundstone tools, can easily be interpreted as a camp where acorns were gathered and processed. However, indications of this activity were greatly overshadowed by the evidence of core/biface reduction that dominated the artifact assemblage (Nilsson and Maniery 1987:6-9). The Curtday site also produced a relatively well-rounded tool assemblage, suggesting that it served as more of a base camp than the other foothill localities. As well, it is also noteworthy that no Gunther Series projectile points indicative of late prehistoric occupation were recovered, raising some doubt as to whether this site was used by the ethnographic inhabitants (Nilsson and Maniery 1987:6-4).

The Winchuck site, situated at the confluence of Bear Creek with the Winchuck River, may fit the ethnographic land-use pattern as a fishing site used during the fall salmon run. No tools indicative of this activity were recovered but, as noted by Gould (1966:90), the Tolowa caught fish from inland rivers by means of weirs and thrusting spears, methods that may not be clearly reflected in artifact assemblages recovered during archaeological excavations. The evidence from the Winchuck site suggests that "hunting toolkit maintenance was a principal on-site activity indicating a close association with the actual process of hunting" (Flenniken, Ozbun, and Markos 1992a:97). No direct evidence of acorn gathering and processing was found. As previously noted, the presence of Gunther Series points at the Winchuck site indicates occupation into late prehistoric times, when the site was presumably used by the Athapaskan-speaking Chetco.

In comparison with other investigated sites in the Klamath Mountain foothills, the Winchuck site is interpreted to have been "a longer term habitation site where a greater diversity of activities occurred" (Flenniken, Ozbun, and Markos 1992a:98). This interpretation may be appropriate when comparing the Winchuck site to the Miller's Ridge sites, which have been interpreted as "resource extraction (task specific) and logistical base camp locations" (Flenniken, Ozbun, and Markos 1992b:105). However, the Bravo Creek and Winchuck site assemblages appear closely comparable, and the Curtday site assemblage clearly reflects a greater range of activities than is in evidence at the other foothill sites (Table 10).

Localities like the Bravo Creek site and the Miller's Ridge sites, situated on high ridgeside terraces in the foothills, do not appear to easily fit within the ethnographic land-use pattern. Core/biface reduction is clearly the principal activity at these localities, and artifacts associated with acorn gathering or other plant use are not represented. Obsidian hydration measurements suggest that the Miller's Ridge sites were used over a long timespan, extending into late prehistoric times. No projectile points were found at the Candy site, however, and all 16 points recovered from the Miller's Ridge site are leaf-shaped, which as previously discussed are not reliable as time markers. The small narrow-necked points found at the Bravo Creek site are easily assignable to the late prehistoric Gunther Series, suggesting that this locality was in fact used by ethnographic peoples.

One final aspect of the ethnographic land-use pattern that should be noted concerns the traditional concepts of land and resource ownership. According to Gould (1975:163-164), each Tolowa village claimed tracts of shoreline, thus ensuring access to the staple subsistence resources. Although this system of land tenure apparently did not extend into the interior, where ownership of particular oak groves as well as fishing places along the streams was maintained by individuals or families, it is clear that the inhabitants of each village nevertheless had "traditional use areas" in the interior (Gould 1966:89). The implication of this situation is that some potential may exist for identification of prehistoric group territories through the recovery of distinctive artifact types.

In this respect, it is noteworthy that the small leaf-shaped points/preforms and the small narrow-necked points with shallow notches and short barbs found at the Bravo Creek site are also clearly represented at the nearby Lone Ranch Creek shell midden located 8 km to the southwest on the southern Oregon coast. In the report of investigations prepared for that site these specimens were classified as point types Nab_1 and SAb, respectively (Berreman 1944:29, Plate VII). While it is probably unwise to over-interpret the significance of this close similarity in projectile point styles, considering the ethnographic land-use pattern it seems reasonable to suggest that the inhabitants of the Lone Ranch Creek and Bravo Creek sites may have been part of the same social group. While clearly speculative, this interpretation suggests that the lithic workshop at the Bravo Creek site was probably visited during the seasonal movement inland for the purpose of acorn gathering and fishing by people from the Lone Ranch Creek village on the southern Oregon coast.

CONCLUSIONS

The Bravo Creek site and the other archaeological sites so far investigated in the Klamath Mountain foothills appear to represent an aspect of the settlement-subsistence system of prehistoric peoples who lived along the southern Oregon coast. The primary activity in evidence at these localities is core/biface reduction. With the exception of the Curtday site where evidence of plant processing was found, stone tool manufacture and tool use related to hunting are virtually the only activities represented. On the basis of projectile point cross-dating and obsidian hydration measurements, use of these foothill sites seems to have considerable time depth, apparently occurring on a regular basis over perhaps the last 4000-6000 years.

The Bravo Creek and other foothill sites do not easily fit into the ethnographic land-use pattern. As the Athapaskan-speaking peoples inhabiting this region at the time of historic contact are thought on linguistic grounds to have arrived only within the last 1000 years, this situation may be due in part to the fact that these sites may have been used by earlier prehistoric peoples with different settlement-subsistence systems. It is also possible that the lack of mention of lithic reduction sites in the foothills may simply reflect shortcomings in the ethnographic record, which was not compiled until long after historic contact. It is now well known that the native population declined drastically as a result of contact with Euro-Americans. Consequently, the ethnographic record may not fully reflect the complexities of settlement and subsistence practices in the prehistoric period (Draper 1988).

The paucity of ethnographic information relating to the manufacture of stone tools may also be a reflection of the place that the procurement, production, and maintenance of stone tools had within a hunter-gatherer settlement-subsistence system. The acquisition of lithic material and the manufacture of stone tools was often a secondary activity that was "embedded" within other primary subsistence activities (Binford 1979:259; Gamble 1986:275-277; Torrence 1983:12). Thus, because stone tool manufacture was undertaken within the context of other basic subsistence activities it would not have been recognized by the participants as a "major procurement system" that required a scheduled procurement strategy solely for its accomplishment.

Judging from the numerous small narrow-necked projectile points recovered, the Bravo Creek site continued to be used into late prehistoric times. In this respect, the lithic workshop at the Bravo Creek site appears to represent an aspect of the settlement-subsistence system of peoples associated with the Gunther Pattern. The Gunther Pattern has been previously defined on the basis of cultural assemblages recovered from villages and other settlements along the immediate coastal margin. Lithic workshop localities in the foothills like the Bravo Creek site have not been previously documented as part of the Gunther Pattern. The new information provided by the Bravo Creek site, when considered together with the results of investigations at other inland localities such as the Winchuck and Miller's Ridge sites, suggests that the late prehistoric peoples of the southern Oregon coast made greater use of the foothills environment than has been previously recognized.

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APPENDIX A:

INVENTORY OF ARTIFACTS RECOVERED FROM THE BRAVO CREEK SITE

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Table A-1. Summary of artifacts recovered from the test unit excavations.

	LEVEL											
Artifact Class	S	1	2	3	4	5	6	7	8	9	10	Total
Test Unit 1												
Bifaces	-	2	-	1	1	-						4
Core	-	-	-	1	-	-						1
Debitage												
Obsidian	-	20	46	17	14	1						98
Chert	-	185	272	129	68	46						700
Test Unit 2												
Projectile Point	-	-	-	-	-	1	-	-	-			1
Preform	-	-	-	-	-	1	-	-	-			1
Bifaces	-	3	-	3	1	1	2	-	-			10
Unifaces	-	-	-	2	-	-	-	-	-			2
Used Flake	-	-	-	1	-	-	-	-	-			1
Cores	-	1	-	1	1	-	-	-	-			3
Hammerstone	-	1	-	-	-	-	-	-	-			1
Flaked cobble	-	-	-	1	-	-	-	-	-			1
Debitage												
Obsidian	-	18	25	29	28	12	10	5	2			129
Chert	-	208	157	258	239	164	148	52	23			1249
Test Unit 3												
Projectile Point	-	2	-	-	-	1	1	-	-			2
Preform	-	1	-	-	-	-	-	-	-			1
Bifaces	-	-	-	2	1	1	1	1	-			6
Unifaces	-	1	-	2	-	-	-	-	-			3
Cores	-	1	-	-	1	1	-	-	-			3
Flaked Cobble	-	-	-	1	-	-	-	-	-			1
Debitage												
Obsidian	-	25	16	9	11	5	8	3	1			78
Chert	6	873	296	293	368	211	287	137	40			2511
Basalt	-	2	1	-	-	-	-	-	-			3
Test Unit 4												
Point Tip	-	-	1	-	-	-	-	-	-	-	-	1
Preform	-	-	-	-	1	-	-	-	-	-	-	1
Bifaces	-	-	1	-	3	-	1	-	-	-	-	5
Unifaces	-	-	2	1	-	-	-	-	-	-	-	3

Table A-1 (continued)

	LEVEL											
Artifact Class	S	1	2	3	4	5	6	7	8	9	10	Total
Test Unit 4												
Used Flake	-	-	-	-	-	1	-	-	-	-	-	1
Cores	-	-	3	-	-	-	-	-	-	-	-	3
Hammerstone	-	-		1	-	-	-	-	-	-	-	1
Debitage												
Obsidian	-	8	18	12	8	11	7	2	1	-	-	67
Chert	-	434	454	340	244	339	262	54	23	7	-	2157
Test Pit 5	-	-	-	-	-	-						-
Test Unit 6												
Preform	-	-	-	-	-	-	-	1	-			1
Bifaces	-	1	-	-	1	1	1	-	-			4
Unifaces	-	1	-	1	1	-	-	-	-			3
Used Flakes	-	-	-	-	-	-	1	1	-			2
Hammerstone	-	1	-	1	-	-	-	-	-			2
Debitage												
Obsidian	-	7	7	2	5	6	7	1	3			38
Chert	-	297	140	123	166	165	283	183	79			1436
Test Unit 7												
Projectile point	-	-	-	-	-	1	-	-	-			1
Biface	-	-	-	-	1	-	-	-	-			1
Used Flakes	-	-	-	-	1	-	1	-	-			2
Debitage												
Obsidian	-	7	3	3	1	-	1	-	1			16
Chert	-	271	97	91	96	81	71	18	18			743
Basalt	-	1	-	1	-	-	-	-	-			2
Test Unit 8												
Biface	-	-	1	1	-	-	-					2
Debitage												
Obsidian	-	3	9	6	1	1	-					20
Chert	-	238	381	114	49	30	14					826

Table A-1 (continued)

	LEVEL											
Artifact Class	S	1	2	3	4	5	6	7	8	9	10	Total
Test Unit 9												
Bifaces	-	1	-	1	2	-	1					5
Uniface	-	-	-	-	1	-	-					1
Battered Cobble	-	1	-	-	-	-	-					1
Debitage												
Obsidian	-	1	2	1	6	5	2					16
Chert	-	225	387	83	78	91	35					899
Test Unit 10												
Projectile Point	-	-	1	-	-	-	-	-	-			1
Preform	-	-	-	-	1	-	-	-	-			1
Bifaces	-	-	2	1	-	-	2	-	-			5
Unifaces	-	-	1	-	1	-	-	-	-			2
Used Flake	-	-	1	-	-	-	-	-	-			1
Core	-	-	1	-	-	-	-	-	-			1
Hammerstone	-	-	-	1	-	-	-	-	-			1
Flaked Cobbles	-	-	-	1	-	-	-	-	-			1
Debitage												
Obsidian	-	4	13	5	3	4	5	1	5			40
Chert	-	191	251	168	126	334	152	184	77			1483
Test Unit 11												
Projectile point	-	-	1	-	-	-	-	-	-			1
Preform	-	-	-	1	-	-	-	-	-			1
Bifaces	-	2	-	-	-	3	-	-	-			5
Endscraper	-	-	-	-	-	1	-	-	-			1
Used Flake	-	-	-	-	-	-	-	1	-			1
Core	-	-	1	-	-	-	-	-	-			1
Flaked Cobble	-	-	-	-	1	-	-	-	-			1
Pipe Stem	-	1	-	-	-	-	-	-	-			1
Debitage												
Obsidian	-	6	6	4	1	2	1	1	-			21
Chert	-	234	197	133	146	113	137	126	21			1107
Test Unit 12												
Biface	-	1	-	-								1
Uniface	-	1	-	-								1

Table A-1 (continued)

Artifact Class	LEVEL S	1	2	3	4	5	6	7	8	9	10	Total
Test Unit 12												
Debitage												
Obsidian	-	10	3	-								13
Chert	-	291	52	12								355
Test Unit 13												
Projectile Point	-	1	-	-	-	-	-	-	-			1
Bifaces	-	-	2	-	-	1	1	-	-			4
Unifaces	-	1	-	1	1	-	-	-	-			3
Core	-	-	-	-	-	1	-	-	-			1
Anvilstone	-	-	-	-	1	-	-	-	-			1
Debitage												
Obsidian	-	14	9	7	11	7	13	5	1			67
Chert	-	490	204	145	177	320	373	212	126			2047
Basalt	-	1	1	-	-	-	-	-	-			2
Test Unit 14												
Bifaces	-	6	-	-	-	-	1	1				8
Unifaces	-	-	-	-	1	-	-	1				2
Anvilstones	-	-	-	1	-	1	-	-				2
Debitage												
Obsidian	-	19	16	11	6	7	7	5				71
Chert	-	639	256	159	205	210	397	122				1988
Basalt	-	-	-	-	-	1	-	-				1
Test Unit 15												
Projectile Point	-	-	-	1	-	-						1
Biface	-	-	-	-	1	-						1
Used flake	-	-	-	1	-	-						1
Core	-	-	1	-	-	-						1
Debitage												
Obsidian	-	11	6	4	9	11						41
Chert	-	296	194	125	293	202						1110

Table A-1 (continued)

	LEVEL											
Artifact Class	S	1	2	3	4	5	6	7	8	9	10	Total
Surface Artifacts												
Projectile Point	1											1
Bifaces	14											14
Unifaces	2											2
Core	1											1
Hammerstones	7											7
Anvilstones	5											5
Flaked Cobble	4											4
Flaked Spalls	7											7
Debitage												
Obsidian	1											1
Chert	4											4
TOTAL												
Projectile Points	1	2	1	1	-	3	1	-	-	-	-	9
Point Tip	-	-	1	-	-	-	-	-	-	-	-	1
Preforms	-	-	-	1	2	1	-	1	-	-	-	6
Bifaces	14	16	6	9	11	7	10	2	-	-	-	75
Unifaces	2	4	3	6	6	-	-	1	-	-	-	22
Endscraper	-	-	-	-	-	1	-	-	-	-	-	1
Used Flakes	-	-	1	2	1	1	2	2	-	-	-	9
Cores	1	2	6	2	2	2	-	-	-	-	-	15
Hammerstones	7	2	-	3	-	-	-	-	-	-	-	12
Anvilstones	5	-	-	1	1	1	-	-	-	-	-	8
Flaked Cobbles	4	-	-	3	1	-	-	-	-	-	-	8
Battered Cobbles	-	1	-	-	-	-	-	-	-	-	-	1
Flaked Spalls	7	-	-	-	-	-	-	-	-	-	-	7
Pipe Stem	-	1	-	-	-	-	-	-	-	-	-	1
Debitage												
Obsidian	1	153	179	109	104	72	61	23	14	-	-	716
Chert	10	4872	3338	2173	2255	2306	2159	1088	407	7	-	18615
Basalt	-	4	2	1	-	1	-	-	-	-	-	8
TOTAL TOOLS	41	28	19	28	24	16	13	6	-	-	-	175
TOTAL DEBITAGE	11	5029	3519	2283	2359	2379	2220	1111	421	7	-	19339

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APPENDIX B:

OBSIDIAN HYDRATION RIND MEASUREMENT DATA FROM THE BRAVO CREEK SITE (35CU123)

by Thomas M. Origer

SONOMA STATE UNIVERSITY
ACADEMIC FOUNDATION, INC.

ANTHROPOLOGICAL STUDIES CENTER
CULTURAL RESOURCE FACILITY
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Foundation Center, Bldg. 300
1801 East Cotati Avenue
Rohnert Park, California 94928

Mr. Reg Pullen
District Archaeologist
Bureau of Land Management
1300 Airport Lane
North Bend, Oregon 97459

July 13, 1993

Dear Mr. Pullen:

This letter reports hydration band measurements obtained from 12 specimens from the Bravo Creek site (35CU123), southwestern Oregon. This hydration work was done per your instructions following source analysis by Richard Hughes who sent the specimens to me.

The analysis was completed at the Sonoma State University Obsidian Hydration Laboratory, an adjunct of the Anthropological Studies Center, Department of Anthropology. Procedures used by our hydration lab for thin section preparation and hydration band measurement are described below.

Each specimen was examined in order to find two or more surfaces that would yield edges which would be perpendicular to the microslide when preparation of the thin section was completed. Two small parallel cuts were made at an appropriate location along the edge of each specimen with a 4 inch diameter circular saw blade mounted on a lapidary trimsaw. The cuts resulted in the isolation of a small sample with a thicknesses of approximately one millimeter. Each sample was removed from its specimen and mounted with Lakeside Cement onto permanently etched petrographic microslides.

The thickness of the samples was reduced by manual grinding with a slurry of #500 silicon carbide abrasive on a glass plate. The grinding was completed in two steps. The first grinding was terminated when the sample's thickness was reduced by approximate 1/2, thus eliminating any micro-chips created by the saw blade during the cutting process. The slides were then reheated, which liquified the Lakeside Cement, and the samples inverted. The newly exposed surfaces were then ground until the proper thickness was attained.

The correct thin section thickness was determined by the "touch" technique. A finger was rubbed across the slide, onto the sample, and the difference (sample thickness) was "felt." The second technique employed for arriving at proper thin section thickness is termed the "transparency" test. The microslide was held up to a strong source of light and the translucency of the thin section observed. The sample was sufficiently reduced in thickness when the thin section readily allowed the passage of light.

A protective coverslip was affixed over the thin sections when all grinding was completed. The completed microslides are curated at our hydration lab under File No. 93-H1227.

The hydration bands were measured with a strainfree 40 power objective and a Bausch and Lomb 12.5 power filar micrometer eyepiece on a Nikon petrographic microscope. Six measurements were taken at several locations along the edge of the thin section. The mean of the measurements was calculated and listed on the enclosed table with other information. These hydration measurements have a range of +/- 0.2 due to normal limitations of the equipment.

We do not have the sourcing results; however, the hydration measurements are provacative. There are two clusters of measurements, one with a mean of about 1.2 and the second with a mean of approximately 2.3 microns. These clusters could be a function of differing hydration rates with one source(s) having a slower rate then the other(s). Another possibility is that the clusters represent two period of site occupation. The artifact inventory and obsidian source might suggest the reason for two hydration measurement clusters.

If you have questions regarding this hydration work, please don't hesitate to contact me.

Sincerely,

Thomas M. Origer, Director
Obsidian Hydration Laboratory

35-CU-123 **Submittor: Reg Pullen - BLM** July 12, 1993

Lab#	Catalog#	Description	Unit	Depth	Remarks	Measurements	Mean	Source
01	TP 1-2	Debitage			none	2.4 2.4 2.4 2.4 2.5 2.6	2.5	
02	TP 2-2	Debitage			none	2.5 2.6 2.6 2.6 2.6 2.6	2.6	
03	TP 2-3	Biface fragment			none	1.2 1.2 1.2 1.2 1.2 1.2	1.2	
04	TP 3-2	Debitage			none	2.4 2.5 2.5 2.5 2.5 2.6	2.5	
05	TP 3-7	Biface fragment			none	2.0 2.0 2.0 2.0 2.0 2.0	2.0	
06	TP 6-5	Debitage			none	2.3 2.4 2.4 2.4 2.4 2.4	2.4	
07	TP 6-6	Debitage			none	2.0 2.0 2.0 2.0 2.1 2.3	2.1	
08	TP 6-8	Debitage			none	2.3 2.3 2.4 2.4 2.4 2.4	2.4	
09	TP 10-1	Debitage			none	1.2 1.2 1.2 1.2 1.2 1.2	1.2	
10	TP 10-2	Debitage			none	1.2 1.3 1.3 1.4 1.4 1.4	1.3	
11	TP 14-5	Debitage			none	2.0 2.1 2.1 2.1 2.3 2.3	2.2	
12	IP-6	Debitage			none	1.2 1.2 1.2 1.2 1.2 1.3	1.2	

Lab Accession No.: 93-H1227 **Technician: Thomas M. Origer**

APPENDIX C:

X-RAY FLUORESCENCE (XRF) DATA FOR THE BRAVO CREEK SITE (35CU123)

by Richard E. Hughes

June 17, 1993

Mr. Reg Pullen
District Archaeologist
Bureau of Land Management
1300 Airport Lane
North Bend, OR 97459

Dear Reg:

Enclosed with this letter you will find a table and a figure presenting x-ray fluorescence (xrf) data generated from the analysis of 12 obsidian artifacts from the Bravo Creek site (35-CU-123) and a midsection fragment of a large obsidian biface from site 35-CS-1, southwestern Oregon. This research was conducted pursuant to U.S.D.I. (Bureau of Land Management) purchase order no. 1422H120P30079

Laboratory investigations were performed on a Spectrace™ 5000 (Tracor X-ray) energy dispersive x-ray fluorescence spectrometer equipped with a Rh x-ray tube, a 50 kV x-ray generator, with microprocessor controlled pulse processor (amplifier) and bias/protection module, a 100 mHz analog to digital converter (ADC) with automated energy calibration, and a Si(Li) solid state detector with 150 eV resolution (FWHM) at 5.9 keV in a 30 mm^2 area. The x-ray tube was operated at 35.0 kV, .28 mA, using a .127 mm Rh primary beam filter in an air path at 200-300 seconds livetime to generate x-ray intensity data for elements zinc (Zn Kα), gallium (Ga Kα), rubidium (Rb Kα), strontium (Sr Kα), yttrium (Y Kα), zirconium (Zr Kα), and niobium (Nb Kα), while iron vs. manganese (Fe Kα/Mn Kα) ratios were computed from data generated by operating the x-ray tube at 12.0 kV, .30 mA, with a .127 mm aluminum (Al) filter at 200-300 seconds livetime. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line established for each element from analysis of up to 26 international rock standards certified by the U.S. Geological Survey, the U.S. National Institute of Standards and Technology (formerly National Bureau of Standards), the Geological Survey of Japan, and the Centre de Recherches Petrographiques et Geochimiques (France). Further details pertaining to x-ray tube operating conditions and calibration appear in Hughes (1988).

Trace element values on the enclosed table (except Fe/Mn ratios) are expressed in quantitative units (i.e. parts per million [ppm] by weight), and these were compared directly to values for known obsidian sources that appear in Hughes (1985; 1986), Hughes and Mikkelsen (1986), Jack (1976), and Skinner (1983). Artifacts were matched to the profiles of known geochemical types of obsidian on the basis of correspondences (at the 2-sigma level) in diagnostic trace element concentration values (i.e., ppm values for Rb, Sr, Y, Zr and, when necessary, Fe/Mn ratios). Artifact-to-obsidian source (geochemical type) correspondences were considered reliable if diagnostic mean measurements for artifacts fell within 2 standard deviations of mean values for source standards. The term "diagnostic" is used to specify those trace elements that are well-measured by x-ray fluorescence, and whose concentrations show low intra-source variability and marked variability across sources. Diagnostic elements, then, are those whose concentration values allow one to draw the clearest geochemical distinctions between sources (see Hughes 1990; Hughes and Lees 1991). Although Ga and Nb ppm concentrations also were measured and reported for each specimen, they are not considered "diagnostic" because they don't usually vary significantly across obsidian sources (see Hughes 1982, 1984). This is particularly true of Ga, which occurs in concentrations between 10-30 ppm in nearly all sources in the study area. Zn ppm values are infrequently diagnostic; they are always high in Zr-rich, Sr-poor peralkaline volcanic glasses, but otherwise they do not usually vary significantly between non-peralkaline sources.

The trace element concentration measurements presented herein are reported to the nearest ppm in the accompanying table to reflect the resolution capabilities of non-destructive energy dispersive x-ray fluorescence spectrometry. The resolution limits of the present x-ray fluorescence system for the determination of Zn is about 3 ppm; Ga about 2 ppm; for Rb about 4 ppm; for Sr about 3 ppm; Y about 2 ppm; Zr about 5 ppm; and Nb about 3 ppm. When counting and fitting error uncertainty estimates (the "±" value in the table) for a sample are greater than calibration-imposed limits of resolution, the larger number is a more conservative reflection of composition variation and measurement error due to differences in sample size, surface and x-ray reflection geometry (see Hughes 1988).

The obsidian source (chemical type) attribution for each specimen appears on the data table. All 12 samples from CU-123 and the obsidian biface fragment from CS-1 match the trace element profile of the high quality glasses of the Grasshopper Flat/Lost Iron Well/Red Switchback [GF/LIW/RS] chemical group of the Medicine Lake Highland volcanic field (see Hughes 1986: Map 8, pp. 289-290, 300-301). Since it is sometimes not possible to draw statistically valid distinctions between obsidians of the Grasshopper Flat/Lost Iron Well/Red Switchback (GF/LIW/RS) and East Medicine Lake (EML) varieties solely on the basis of contrasts in Rb, Sr, Y and Zr concentration estimates (Hughes 1986: 81-82), all specimens with Rb, Sr, Y and Zr concentration estimates overlapping at 2σ with GF/LIW/RS and EML obsidians were analyzed a second time to generate Fe/Mn ratio data because, based on previous research, it was found that iron to manganese (Fe $K\alpha$/Mn $K\alpha$) ratios assist in segregating the two source (chemical) types (see Hughes 1986: 82, Fig. 8). Despite the fact that differences between the x-ray hardware and analysis conditions originally employed to separate GF/LIW/RS and EML glasses (cf. analysis conditions reported in Hughes 1986:25-30 with those on page 1 herein) yielded, not unexpectedly, slightly different concentration values and ratios (see Figures 1-2; cf. Hughes 1986: Table 8, Figure 8), the distinctions previously recognized between the GF/LIW/RS and EML chemical types (e.g. EML glass with slightly higher Zr ppm values and Fe/Mn ratios than GF/LIW obsidians; Hughes 1986: Table 8, Figure 8) were reaffirmed in the present study. These distinctions can be seen in Figure 1, a bivariate scatter diagram plotting GF/LIW (open circles) and EML (open squares) source standards in relation to values determined for CU-123 and CS-1 artifacts (from the data table).

I hope this information will help in your analysis of these site materials. Please contact me at my laboratory ([916] 364-1074) if I can be of further assistance. As you requested, I have forwarded the 12 samples from 35-CU-123 to Tom Origer for obsidian hydration analysis, and have returned the biface fragment from 35-CS-1 herein.

Sincerely,
Richard Hughes
Richard E. Hughes, Ph.D.

encl.

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6/17/93
R. E. Hughes

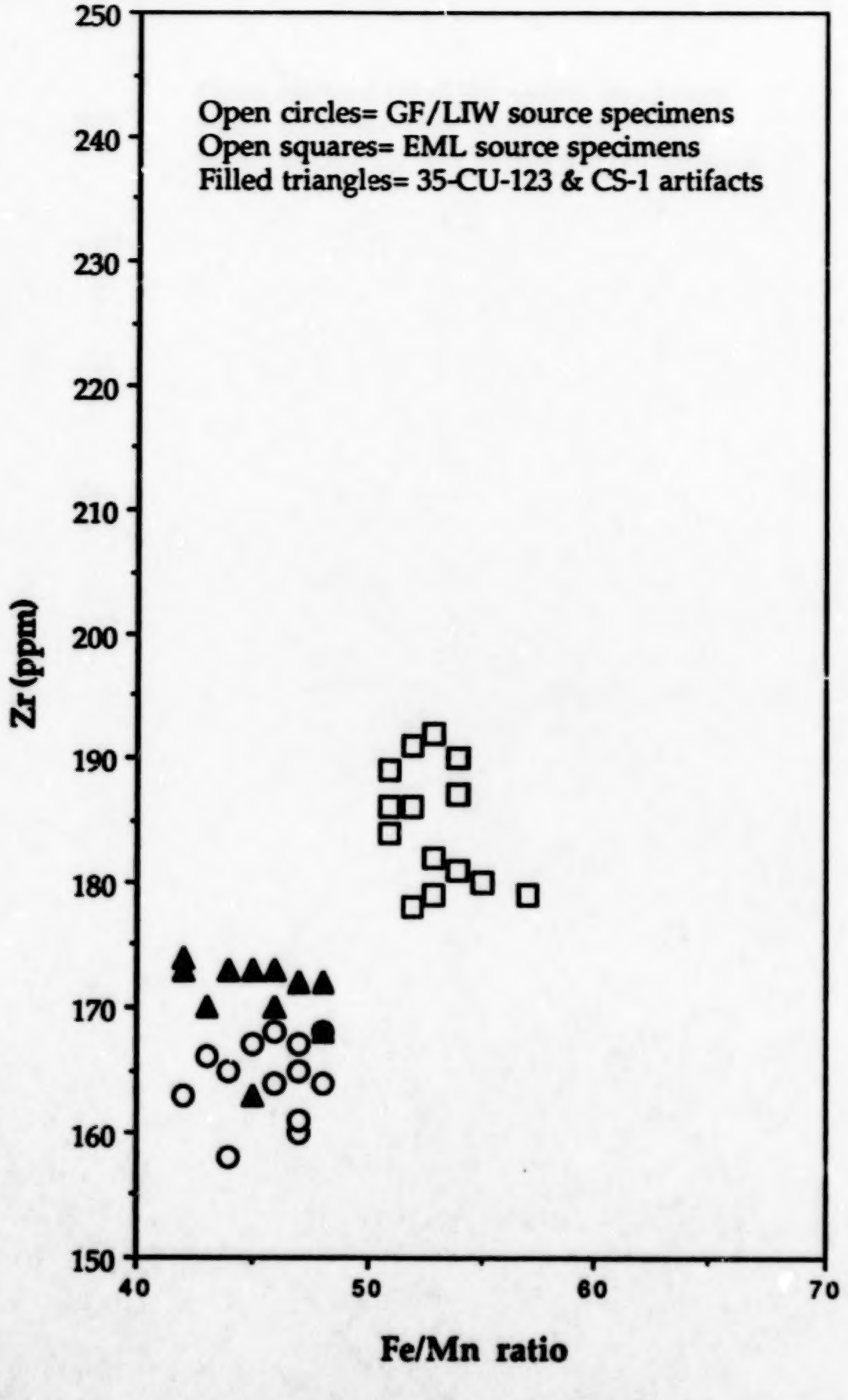
35-CU-123 and 35-CS-1 Xrf Data
Page 1 of 1

Specimen Number	Trace Element Concentrations								Ratio	Obsidian Source (Chemical Group)
	Zn	Ga	Rb	Sr	Y	Zr	Nb	Ba	Fe/Mn	
TP1-2	28 ±7	15 ±3	131 ±4	62 ±3	28 ±2	173 ±5	10 ±3	nm	45	GF/LIW/RS, Med. Lake Highland
TP2-2	44 ±8	14 ±5	143 ±5	72 ±4	31 ±3	170 ±5	7 ±3	nm	43	GF/LIW/RS, Med. Lake Highland
TP2-3	36 ±6	15 ±3	128 ±4	63 ±3	26 ±2	163 ±5	8 ±3	nm	45	GF/LIW/RS, Med. Lake Highland
TP3-2	51 ±7	16 ±4	153 ±5	70 ±3	30 ±2	174 ±5	11 ±3	nm	42	GF/LIW/RS, Med. Lake Highland
TP3-7	52 ±8	20 ±4	145 ±5	69 ±4	31 ±2	173 ±5	10 ±3	nm	42	GF/LIW/RS, Med. Lake Highland
TP6-5	39 ±6	15 ±3	130 ±4	66 ±33	29 ±2	173 ±5	11 ±3	nm	44	GF/LIW/RS, Med. Lake Highland
TP6-6	41 ±7	19 ±4	141 ±5	68 ±3	32 ±2	172 ±5	11 ±3	nm	48	GF/LIW/RS, Med. Lake Highland
TP6-8	30 ±7	14 ±4	132 ±5	66 ±3	29 ±2	173 ±5	9 ±3	nm	46	GF/LIW/RS, Med. Lake Highland
TP10-1	47 ±6	18 ±4	150 ±5	71 ±3	32 ±2	174 ±5	10 ±3	nm	42	GF/LIW/RS, Med. Lake Highland
TP10-2	34 ±7	16 ±4	136 ±5	69 ±3	31 ±2	172 ±5	11 ±3	nm	47	GF/LIW/RS, Med. Lake Highland
TP14-5*	54 ±7	16 ±4	140 ±5	77 ±3	29 ±2	170 ±5	12 ±3	nm	46	GF/LIW/RS, Med. Lake Highland
IF-6*	42 ±6	14 ±3	136 ±4	67 ±3	30 ±2	168 ±5	10 ±3	nm	48	GF/LIW/RS, Med. Lake Highland
35-CS-1, 110*	73 ±5	14 ±3	121 ±4	67 ±3	25 ±2	172 ±5	8 ±3	nm	48	GF/LIW/RS, Med. Lake Highland

---

All trace element values in parts per million (ppm); ± = pooled estimate (in ppm) of x-ray counting uncertainty and regression fitting error at 200 and 300 (*) seconds livetime; nm. = not measured. All samples from 35-CU-123 except sample 110 from 35-CS-1.

Figure 1. Zr ppm vs. Fe/Mn ratio data for 35-CU-123 and 35-CS-1



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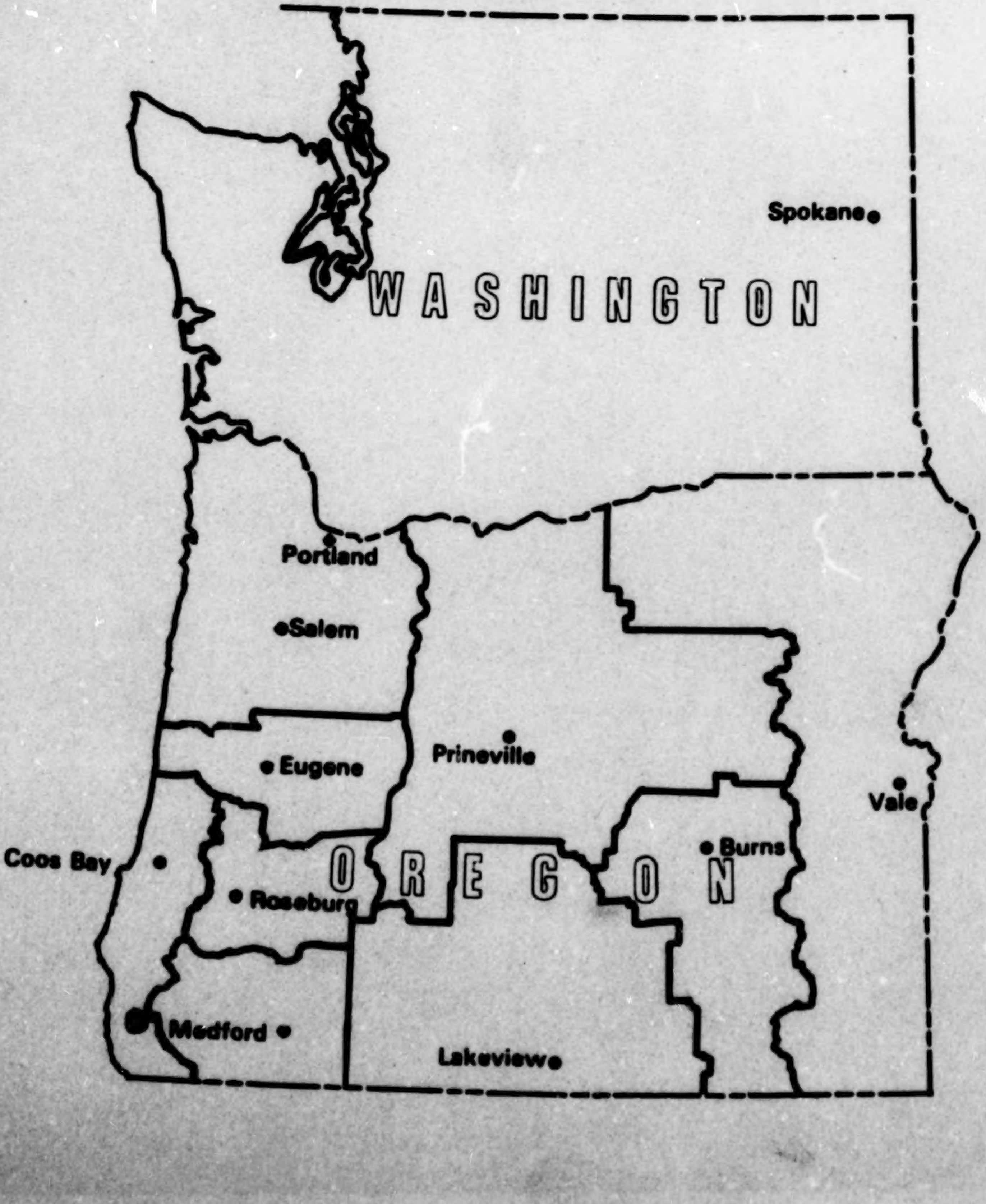
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